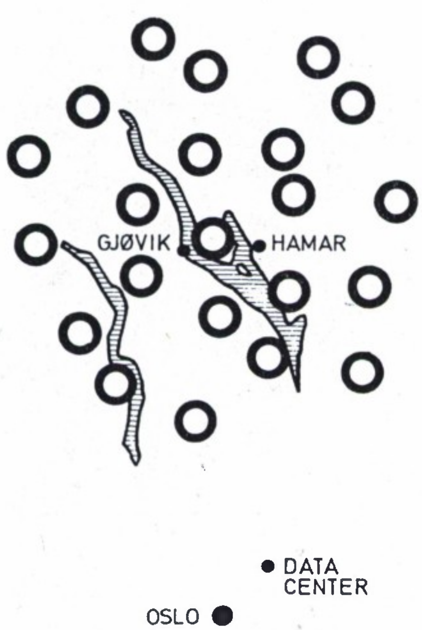
Royal Norwegian Council for Scientific and Industrial Research



NORWEGIAN SEISMIC ARRAY

NORSAR

NTNF/NORSAR
P.O. Box 51
N-2007 Kjeller
NORWAY

NORSAR Report No. 51
Budget Bureau No. 22-RO293

ARRAY MONITORING AND FIELD MAINTENANCE REPORT

1 July - 31 December 1972

by

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20 January 1973

The NORSAR research project has been sponsored by the United States of America under the overall direction of the Advanced Research Projects Agency and the technical management of Electronic Systems Division, Air Force Systems Command, through Contract No. F19628-70-C-0283 with the Royal Norwegian Council for Scientific and Industrial Research.

This report has been reviewed and is approved.

Richard A Jedlicka, Capt USAF
Technical Project Officer
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ESD Detachment 9 (Europe)

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Date of Contract	:	15 May 1970
Amount of Contract	:	$ 2,051,886
Contract No.	:	F19628-70-C-0283
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Title of Contract	:	Norwegian Seismic Array (NORSAR) Phase 3

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FIGURES

TABLES

ABBREVIATIONS

ADC	-	Analog-to-Digital Converter
AM	-	Array Monitoring
ATC	-	Alternate Telemetry Command/EOC
BE Card	-	Lightning Protection Card
CCB	-	NORSAR Change and Control Board
CTV	-	Central Terminal Vault
DP	-	Detection Processor
EOC	-	Experimental Operations Console
EP	-	Event Processor
EPU	-	SLEM External Power Unit
FM	-	Frequency Modulation
FMC	-	Field Maintenance Center (Brumunddal)
LP	-	Long Period
LPV	-	LP Sensor Vault
LTA	-	Line Termination Attenuator
MC	-	Maintenance Center (Kjeller)
NAS	-	NORSAR SP Analog Station
NDPC	-	NORSAR Data Processing Center
NMC	-	NORSAR Maintenance Center (Stange)
NTA	-	Norwegian Telegraph Administration
RA-5	-	SP Seismograph Amplifier
RCD	-	Remote Centering Device
RSA/ADC	-	Range Scaling Amplifier/ADC
SLEM	-	Short and Long Period Electronic Module
SP	-	Short Period
SPS	-	Special Processing System
WHV	-	Well Head Vault
WWSSN	-	World Wide Standard Seismic Network

SUMMARY

The report, covering the period 1 July - 31 December 1972, discusses the field maintenance of the array, the remote array monitoring and their interaction. The routines for the maintenance and monitoring tasks, and the monitoring program package are described.

All parts of the array field instrumentation have operated satisfactorily. Cable breakages, however, have caused large "down time" on certain subarrays, especially at 05B. All preventive and corrective maintenance projects initiated last period have with few exceptions been completed.

An analog seismograph, located at NDPC, has been added to the data acquisition system. A new NORSAR maintenance center has been established at Stange.

1. INTRODUCTION

The work presented in this report consists of remote monitoring of NORSAR performed at NDPC and array maintenance performed by the NORSAR field technicians. This work is in the following labelled "AM" or "AM work". All task objectives indicated in the report were accomplished during the period 1 July - 31 December 1972 and are detailed in the subsequent sections.

The modems of NORSAR have been maintained by the NORSAR field technicians as in the last reporting period, but for convenience the management of this work has been transferred to other NDPC personnel. This also includes responsibility for cooperation with NTA (Norwegian Telegraph Administration) on proper maintenance and monitoring of the communication network between NORSAR and NDPC. This work is therefore documented in (2).

As a tool for the seismologists in the routine analysis of seismic events, an analog SP recorder station has been installed at NDPC during the period. The output from a conventional SP seismometer is transmitted without digitalization from 05C to NDPC.

The preparations to erect a permanent and more suitable field maintenance center than the present FMC were initiated during the period. The center was ready at the end of the year. The new center (NMC) is located near Stange - a few kilometers from 04B/CTV. The previous maintenance center (MC) at Kjeller was closed down in June 1972. All workshop activities in the period took place at FMC. From 1 January 1973 NMC will replace FMC.

Appendix I includes a brief description of the features of the program system used in the remote monitoring of the array. Appendix II lists the instrumentation available at FMC for routine workshop and field maintenance. The tolerances of the NORSAR field equipment are presented in Appendix III.

1.1 Objectives

The AM work is defined in contract number F19628-70-C-0283 entered between U.S. Department of the Air Force/ESD and the Royal Norwegian Council for Scientific and Industrial Research (NTNF). The contract objectives for AM are:

Task 1: Maintenance of NORSAR subarrays

a) Develop and perform a preventive and corrective field maintenance program that is integrated with the NDPC remote calibration and maintenance analysis capability. This maintenance program will include all 22 subarrays with their physical facilities such as seismometers, intra-subarray communications, electronics, instrumentation, power supplies, vaults and access roads.

This program will include repair, calibration and replacement of defective subarray components.

b) Provide and maintain workshop facilities for the repair of subarray equipment.

c) Keep detailed records containing work history on subarrays and components, component repair history, failure rates and other pertinent data.

Task 2: Remote array monitoring at NDPC

a) Establish procedures for array monitoring (AM) operation and AM reporting. These procedures will include array monitoring and calibration, routine maintenance and emergency array maintenance actions that are an integral part of the NDPC operation.

b) Evaluate array performance, monitor array status and direct the subarray maintenance (conduct routine array calibration and array operations verification using the NDPC AM diagnostics).

c) Maintain the NORSAR AM computer programs. This will include analysis, correction and testing of errors and improvements.

d) Establish and maintain procedures and records that indicate all equipment utilization and performance relevant to AM. This includes periferal support equipment and field equipment where data is gathered by the NDPC operation as part of array calibration, status monitoring and field maintenance assistance.

1.2 AM Personnel

The AM group consisted of 8 persons on full time - six field technicians at FMC, one AM analyst heading the group and his assistant.

The field personnel group has one of the technicians as manager of daily maintenance activities and the FMC. He cooperates closely with the AM analysts and reports to these. The field maintenance work to be accomplished is decided upon in conjunction with him to secure a satisfactory exploitation of available manpower.

1.3 Educational and Consulting Activities

One of the field technicians participated in a course on electrical disturbances in control systems in Sandefjord 14-17 November. Upon request from Geodetic Institute in Copenhagen the Chief Analyst participated as a consultant in a team erecting a WWSSN station on Greenland during August and September (see (6)).

2 NDPC AM OPERATING PLAN

The activation rates for the different AM programs are briefly discussed in Section 2.1. Procedures at NDPC for handling AM data, reporting and cooperating with field personnel are discussed in Section 2.2. A description of the AM programs used in the remote monitoring is given in Appendix I.

2.1 Scheduled Monitoring

2.1.1 Monitoring rates

During the reporting period only two changes to the monitoring schedule have taken place (see Table 2.2). These refer to CS CONTROL which is no longer in regular use, and SACPLP. The array monitoring schedule as of 31 December 1972 is shown in Table 2.1. As will be seen, all AM programs in operation, with the exception of SACPLP, are activated at least once in an eight-week interval.

The chosen monitoring frequency of a subarray using a certain AM program has been reviewed regularly. The rates have been set based on:

1) Experiences of accuracy and reliability of the program.
2) The error rate of or drift in units monitored by the program.
3) Computer time requirement of the program.

Program Name		No. of Week in Cycle							
		1	2	3	4	5	6	7	8
CHANEV	SP	A	B	C	D	A	B	C	D
	LP	AB	CD			AB	CD		
SACP	SP	A	B	C	D	A	B	C	D
	LP*								
LPCAL		AB	CD	AB	CD	AB	CD	AB	CD
SLEMTEST		AB	CD	AB	CD	AB	CD	AB	CD
MISNO		A	B	C	D	A	B	C	D
* Processed every six months per subarray.									

SA Partition Codes:

A	-	01A-05B
B	-	06B-03C
C	-	04C-09C
D	-	10C-14C

TABLE 2.1

NDPC Array Monitoring Schedule

The routine monitoring rates of any subarray in the period using the monitoring programs are shown in Table 2.2 (see also Table 2.1).

Program	Rate 1	Rate 2
CSCONTROL	Weekly until Oct 72	On request only
LPCAL	Biweekly	
SLEMTEST	Biweekly	
MISNO	4th week	
CHANEVSP CHANEVLP	4th week	
SACPSP SACPLP	8th week 8th week until Sept 72	Half yearly thereafter

Table 2.2

Remote Monitoring Rate per Subarray
using the AM Programs

2.1.2 Discussion on rates and programs

2.1.2.1 LPCAL

The activation rate of the program has been constant throughout the period. A larger drift in the mass position (MP) and the free period (FP) of the LP instruments is expected as a result of seasonal temperature changes in the environment of the LP instruments, but no anomalies have been observed. Biweekly monitoring and calibration have been found to be satisfactory.

2.1.2.2 SLEMTEST

The processing rate of this program is explained mainly by the request for quick disclosure of any malfunction of RSA/ADCs and test generators.

2.1.2.3 MISNO

While the program SLEMTEST tests the RSA/ADC for one input voltage, the MISNO program controls the performance in a wide range of voltages. Both tests have been found satisfactory for their use, but the off-line processing time

required by MISNO limits its availability (see Table 2.3).

2.1.2.4 CHANEVSP/LP

These two programs determine very accurately the characteristics of the transfer functions for both SP and LP data channels. They are the most important and advanced programs in the AM program package. However, the time required for a total subarray analysis is considerable (See Table 2.3).

2.1.2.5 SACPSP/LP

No occurrences of distortions, i.e., generation of higher signal harmonics of the input, were disclosed in the LP data channel units in the previous period. The processing rate of SACPLP was therefore further relaxed. The number of distortions disclosed by SACPSP in the period was 2.

2.1.3 Time Requirements

Table 2.3 shows the time requirements of the different AM programs for routine execution. Collection of a data base from a subarray for later off-line analysis is accomplished in parallel with the acquisition of seismic data from other subarrays. To the total amount of off-line computer time required (43 hours per month) has to be added the time required for different types of ad hoc analysis and reruns of off-line programs erroneously executed. Roughly, this adds another 4-5 hours.

PROGRAM	Time req. pr. subarray pr. program execution (min.)		Total time req. pr. month (averaged) for total array			
			Data Collection		Data Analysis	
	Data Collection	Data Analys.	Hours	Mins.	Hours	Mins.
LPCAL	30	-	22	-		
SLEMTEST	85	-	62	20		
MISNO	35	20	12	50	7	20
CHANEVSP	25	35	9	10	12	50
CHANEVLP	80	45	29	20	16	30
SACPSP	10	20	1	50	3	40
SACPLP	50	46	3	3	2	49
Total off-line computer time per month approx. 43 hours.						

TABLE 2.3

Computer Time Required by AM Programs

2.1.4 Visual inspection

To secure an acceptable quality of the data used in the seismic data processing at NDPC, the array status panel on the EOC is monitored daily. In addition, all sensor outputs are visually reviewed, using the EOC waveform display, to identify channels with deteriorating performance caused by abnormal amplitudes, spikes and other non-seismic noise.

All data channels were checked weekly for phase and gain failures, using the waveform display and inserting a sine wave of 1 Hz (SP) and 0.04 Hz (LP) at the calibration coil of the sensors.

Some of the subarrays (CTV/LPV facilities, permanent installations and environment) have been inspected once by the AM analysts in the period (Figure 2.1).

Month		Subarrays 01A	01B	02B	03B	04B	05B	06B	07B	01C	02C	03C	04C	05C	06C	07C	08C	09C	10C	11C	12C	13C	14C
Jan																							
Feb		X	X			X																	
Mar	1972 I																						
Apr										X	X			X	X								
May																							
Jun				X																			
Jul																							
Aug					X							X	X										
Sep																							
Oct	1972 II																			X	X	X	
Nov																X							
Dec			X				X	X	X					X			X						X

Figure 2.1 On-Site Inspection of Subarrays

Other procedures to secure data integrity are:

1) Subarray checkout at NDPC before departure of the maintenance team after a visit. This consists of verbal status reporting by visitor, visual data channel check using the EOC, and SLEM circuit tests.

2) Emergency actions if array status alarms are lit on the EOC.

3) Regular logging of time intervals when any subarray has been masked to survey loss of seismic data - see Daily NORSAR DP Channel Status Report, Figure 2.2.

2.2 AM Internal and External Reporting

All actions at NDPC related to AM tasks which interrupt the normal acquisition of seismic data from one or more subarrays are logged. A board located in the NDPC computer hall is kept permanently updated by AM analysts as a reference on array status for scientific and computer operator personnel.

The field maintenance personnel mails a daily report to NDPC on activities performed at the array sites. The reports are reviewed by AM analysts to get an on-the-spot evaluation of disclosed malfunctions and a comparison with scheduled maintenance tasks. This reporting also gives the necessary feed-back for control of reliability and interpretation of the AM system.

In addition, the field technicians issue a weekly and a monthly report discussing status of FMC and the array in general, and projects not covered by the daily reports.

Biweekly a report on LP system status is sent to ESD/TPO, and a review of all tasks accomplished by the AM group to the NORSAR change and control board (CCB).

A computerized report on all data channels giving the last available information on their performance and status is issued daily. This is based on the parameters calculated by the on-line and off-line AM programs and the visual inspection of the seismometer recordings. (See examples in Figures 2.2-2.3.)

3. ARRAY MONITORING AND FIELD MAINTENANCE

This chapter includes a review of actions of remote array monitoring at NDPC and maintenance accomplished at the subarrays by the field technicians. A "subarray history" for each site is given in Section 3.2. These figures will disclose the relation between NDPC array monitoring and the field maintenance activity. A discussion of faults or maintenance which are of a non-general type is given in 3.2.3. Repairs accomplished at the NORSAR workshops are outlined in 3.2.4. The stability and trend of the array field equipment are discussed in 3.2.5.

The principles for directing the maintenance of the array and the assignment of priorities to different types of equipment errors are briefly discussed in 3.1.

3.1 Maintenance Policy

The strength and flexibility of the AM system imply that only corrective and not preventive maintenance in general is a necessity in maintaining the operating parts of the array. The performance of the array is regularly, and in some ways continuously, controlled by NDPC. Therefore,

NORSAR SP CHANNEL STATUS REPORT
TIME 0000 - 2400

28 DEC 1972

SUB ARRAY	CHAN NO	PERFORMANCE REDUCED	PERFORMANCE BAD	SUBARRAY MASKING-INTERVALS (HHMM)
01B	5	*		
02B	3	*		
05B	3	*		
06B	2		*	
-	3	*		
02C	5	*		
04C				0007-0041
05C				0059-0133
06C				0137-0211
07C				0219-0253
08C				0253-0326
09C				0005-0006 0326-0400
-	3	*		
10C	2		*	
11C	3		*	
-	4	*		
12C				0727-0729 0729-0731
-	2	*		
14C	4	*		

SUB ARRAY	CHAN NO	PERFORMANCE REDUCED	PERFORMANCE BAD	SUBARRAY MASKING-INTERVALS (HHMM)
12C	NS	No output		(Visual EOC-list)

BAD = ONE OR MORE PARAMETERS AT LEAST TWO TOLERANCE INTERVALS AWAY FROM NOMINELL VALUE
REDUCED= ONE OR MORE PARAMETERS WITHIN SECOND TOLERANCE INTERVAL OUTSIDE NOMINELL VALUE
(FOR A MORE DETAILED STATUS OF NORSAR - CONTACT THE AM ANALYST)

NO. OF BAD CHANNELS = 3
NO. OF RED. CHANNELS = 9

Figure 2.2 Daily SP channel status report (Part 1) giving masking intervals of subarrays and channel performance.

SUBARRAY UPDATED	01A 12/16	01B 12/16	02B 12/19	03B 12/16	04B 12/16	05B 12/16	06B 12/23	07B 12/23	01C 12/23	02C 12/23	03C 12/23
01											
02							S*				
03			F			S	S				
04											
05		F								P	
06											
V					P			P		P	
NS											
EW					P S						P

SUBARRAY UPDATED	04C 11/30	05C 11/30	06C 11/30	07C 11/30	08C 11/30	09C 11/30	10C 12/ 7	11C 12/ 7	12C 12/ 7	13C 12/ 7	14C 12/ 7
01											
02							S*		F		
03								S*			
04								F			F
05											
06											
V											
NS			P								
EW										S	

P=PERIOD, F=FILTER CHAR., D=DISTORTION, S=CHANNEL SENS. * = PARAMETER OUTSIDE TWO TOLERANCE INTERVALS

Figure 2.3 Daily SP channel status report (Part 2) giving details on channel characteristics outside tolerance limits as disclosed by CHANEV.

the work program for personnel in the field and the assignment of priorities to the different maintenance jobs should depend on the AM analysts' interpretation of the output of the AM programs.

The field technicians are directed by the AM analysts to perform ad hoc operations at sites where malfunctions or deteriorating performance of instrumentation and electronics are disclosed. The number of visits to the different sites has been high enough to allow regular on-site inspection and satisfactory maintenance of facilities and installations, which cannot be monitored by NDPC.

We have comprehended that to establish a priority scheme which strictly tells in which sequence errors or groups of errors at different subarrays should be corrected does not give a satisfactory utilization of the available manpower and expertise of the field technicians. There are different reasons for this. We have encouraged the technicians to specialize in certain technical sectors of their work. The advantage is obvious but implies that the right man may not be accessible when needed. Secondly, it may be more advisable to let one maintenance team on the same day accomplish work at two subarrays located next to each other, both having "low priority" faults, instead of visiting one with " high priority" faults. Seasonal conditions and problems concerning access to the sites have to be considered, etc. Also, the variety of faults which are experienced during the array monitoring makes the establishment of a definite "threshold" for a maintenance visit to a site difficult.

Loss of data from a whole subarray will, if possible, initiate immediate action. Data loss or limited malfunctioning of one or a few channels of a subarray have to be judged against other tasks.

3.2 Subarray History

3.2.1 Figure Presentation

Figures 3.1 to 3.22 show the interrelation for each subarray between the accomplishment of the remote array monitoring, types of errors disclosed, and the response in the field. Maintenance visits to the sites and corrections to the instrumentation performed by the field technicians are also shown.

The figure abbreviations are:

1) Progr.
Shows the relation between the planned and actual array monitoring schedule (refer Section 2.1.1). The codes refer to the SP and LP versions of the analysis programs and to programs used for checking the performance of the SLEM electronics. Program LPCAL is not shown.

2) Visits.
Shows the time lag between when a maintenance visit has been planned and when it was accomplished.

3) Proj's.
Shows the accomplishment of works of preventive maintenance to be defined in the following:
"SP Work" included:

a) Replacement or, if possible, adjustment of SP seismometer with free period, damping or sensitivity outside tolerance limits

(Refer (3)), as disclosed by AM

b) Modification of RA-5 input cards to suppress 50 Hz noise (Refer (4))

c) Control and maintenance of WHV facilities.

"Constr." included

a) Maintenance of LPV and CTV exterior and interior

b) Pressure testing of seals of LP vaults and tanks

c) Inspection and recalibration of LP sensors if necessary

d) Maintenance of RCD

e) Control of CTV/LPV environment and access roads

f) Redesign of CTV entrances of 01A-07B

4) AM.

Displays malfunctions disclosed by the AM system in the data channels (SP: 1-6, LP: 7-9) or subarray electronics (SLEM) with reference to the faulty parameters. Note that some of the codes refer to phenomena which may occur more places in the data channel (see Table 3.1).

The ACTION subsection tells which action has been accomplished during a maintenance visit (adjustment or replacement of faulty unit) with reference to the channel. Actions on the SLEM electronics are identified.

5) Rect/batt.

Refers to malfunctions disclosed in the rectifier and/ or batteries.

6) Cables.

Gives the time of occurrence of cable breakages.

Channel unit parameter	Code	With reference to:				
		Sensor SP/LP	Amplifier RA-5 Ithaco	LTA	Whole Channel	SLEM
Damping ratio	λ	X				
Nat.Freq.	F_0	X				
Sensitivity	S	X				
Distortion	D	X	X	X		
Mass Position (LP)	MP	X				
Filter Characteristics	F		X	X		
Gain	G		X	X		
Balance	B		X			
DC Offset	DCO				X	
CM Rejection	CMR			X		
Lightning Prot. Card	BE				X	
A/D Converter	ADC					X
Test Generators	Gen's					X

Table 3.1

Identification of data channel subsection where specified faults may occur (refer figures 3.1 to 3.22).

SA: 01A Period: 1 July - 31 December 1972

1. Progr.	SP	CS				C			CS							C	CS				C				CS		
	LP		S		C	C			C	S						C	C		C		C				C		
	SLEM	M	E		EM		E		EM	E		E					EM		E		EM	M	E		EM		E
2. Visits	Planned				X	X		X						X			X		X			X					
	Accompl.					X		X						X			X		X			X					
3. Proj's	SP Work																										
	Constr.							X																			
4. AM	A				7	7										78	89		8								
	Fo																										
	S																8								8		
	D																										
	MF																										
	F					1			1					1													
	G	4												4		4											
	ECO		3	3																							
	CMR																										
	BE Cards																										
	SLEM ADC																				X	X					
	Gen's																										
	Other																										
ACTION:	Adj.					78 35								4			78					a5					
	Rep.													12					8								
5. Rect/Batt																											
6. Cables													m5	m5	m5	m5			m5								
Time (Week of Year)				30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

SA: 01B Period: 1 July - 31 December 1972

		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1. Progr.	SP	CS	C			C			CS				C				CS				C				C		
	LP	C	S		C	C			C		S		C				C		C		C				C		
	SLEM	M	E		E		EM		EM		E		EM		E		EM		E		EM		E		EM		E
2. Visits	Planned		X				X			X							X					X					
	Accompl.		X				X			X							X					X					
3. Proj's	SP Work																										
	Constr.						X										X										
4. AM	λ	57			7	78	7		8	78																	
	Fo		8																								
	S					8			8																		
	D																										
	MP		8																								
	F																										
	G																					1					
	DCO		2														5										
	CMR																										
	BE Cards																										
	SLEM ADC																										
	Gen's																										
	Other									4*																	
ACTION:	Adj.		28				7			78							5					1					
	Rem.		5																								
5. Rect/Batt																											
6. Cables																											

Time (Week of Year) 30 35 40 45 50 53
1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

*Number refers to entry point in Table 3.10.

Figure 3.2 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 02B Period: 1 July - 31 December 1972

1. Progr.	SP	SC				C			SC				C				SC				C				S	C	
	LP	C	S		C				C	S			C				C		C		C				C		
	SLEM	M	E		EM	E			EM	E			EM	E			EM		E		EM	E			EM		E
2. Visits	Planned	X			X			X								X						X			X		
	Accompl.	X						X								X									X		
3. Proj's	SP Work																										
	Constr.							X																			
4. AM	λ	7															8		8		8				8		
	Fo	9																							7		
	S																										
	D																								6		
	MP																										
	F																									3	
	G																										
	DCO								8		8																
	CMR		5		5		5		5		5		5		5	57 8											
	BE Cards																										
	SLEM ADC																										
	Gen's																										
	Other																										
ACTION:	Adj.	7														57 8g									8		
	Rep.	9																							7		
5. Rect/Batt																											
6. Cables																											
	Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

SA: 03B Period: 1 July - 31 December 1972

		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1. Progr.	SP	CS			C				CS				C				CS				C				CS		
	LP	C	S		C		C		C		S		C				C		C		C				C		
	SLEM	M	E		EM		E		EM		E		EM		E		EM		E		EM		E		EM		E
2. Visits	Planned		X					X		X					X							X					
	Accompl.		X					X		X												X					
3. Proj's	SP Work																										
	Constr.							X																			
4. AM	λ																										
	Fo																										
	S																										
	D																										
	MP									9																	
	F		5																								
	G	6	36																		4	14					
	DCO		24		24		24	24																			
	CMR				6				6	6												1					
	BE Cards																										
	SLEM ADC																										
	Gen's																										
	Other									12*																	
ACTION:	Adj.		36					24		6												14					
	Rep.		56							9																	
5. Rect/Batt																											
6. Cables																											

Time (Week of Year): 30, 35, 40, 45, 50, 53 — 1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

* Numbers refer to entry point in Table 3.10

Figure 3.4 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 04B   Period: 1 July - 31 December 1972

1. Progr.	SP	CS			C				CS								CS				C				CS		
	LP	C	S		C				C		S						C		C			C			C		
	SLEM	M	E		EM		E		EM		E		EM		E		EM		E		EM		E		EM		E
2. Visits	Planned	X		X				X				X	X	X	X	X						X					
	Accompl.	X		X				X					X	X		X						X					
3 . Proj's	SP Work																										
	Constr.							X						X		X											
4. AM	λ	9			9			9	9							9	9		9			9			9		
	Fo																										
	S				9				9								9		9								
	D																										
	MP																										
	F																										
	G	2			2			92													5	5					
	DCO																										
	CMR																3										
	BE Cards																										
	SLEM ADC																										
	Gen's																										
	Other	13*		13*				13*																			
ACTION:	Adj.							92								9						5					
	Rep.	DU														e											
5. Rect/Batt																											
6. Cables										2	2	2	2	2	2	2											
	Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

* Numbers refer to entry point in Table 3.10

SA: 05B   Period: 1 July - 31 December 1972

1. Progr.	SP	S						C	CS				C				CS				C				CS		
	LP	C	S		C				C		S		C				C				C	C			C		
	SLEM	M	E		EM		E		EM		E		EM		E		EM		E		EM		E		EM		E
2. Visits	Planned	X	X	X		X	X				X		X	X	X	X	X	X	X	X	X						
	Accompl.	X	X			X	X				X		X	X	X		X	X	X	X	X						
3. Proj's	SP Work	X																									
	Constr.										X																
4. AM	λ																										
	Fo	36																									
	S												9				4								9		
	D																										
	MP																										
	F																										
	G	3					2										2		2	34 6							
	DCO																				26						
	CMR																										
	BE Cards	6											4														
	SLEM ADC												X														
	Gen's					X									X		X		X								
	Other																	X									
ACTION:	Adj.	3				g	2						a				2		2	34 6g	26 ae						
	Rep.	36					2										4	4	g								
5. Rect/Batt																											
6. Cables		2	2	2	2	26	2						2	2	2	2	21 5	5m	5	23 6	23 6						

Time (Week of Year): 30 35 40 45 50 53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

Figure 3.6 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 06B Period: 1 July - 31 December 1972

1. Progr.	SP		S		C	C				CS				C				CS				C				CS	
	LP				C				C		S		C						C			C			C		
	SLEM		EM		E	M	E		E	M	E		E	M	E	M	E	M	E		E		E		E	M	E
2. Visits	Planned	X	X	X			X	X		X	X	X	X	X	X	X	X	X	X		X						
	Accompl.	X		X			X	X			X					X	X	X	X		X						
3. Proj's	SP Work																										
	Constr.							X								X	X				X						
4. AM	A			7																							
	Fo																										
	S																										
	D																										
	MP																										
	F																	2									
	G													6								3				3	
	DCO															13					3						
	CMR																										
	BE Cards	25					25 6																				
	SLEM ADC																										
	Gen's		X				X																				
	Other										10*					10*											
ACTION:	Adj.			7			g	g								13 g					3						
	Rep.	25		gDU			25 6				2					2e DU		2	DU								
5. Rect/Batt											X																
6. Cables																											
Time (Week of Year)				30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

* Number refers to entry point in Table 3.10.

SA: 07B Period: 1 July - 31 December 1972

1. Progr.	SP		CS			C				CS				C				CS				C				CS	
	LP		S							C	S		C				C		C		C				C		
	SLEM		EM		E	M	E		E		EM		E	M	E		E	M	E		E	M	E		E		E
2. Visits	Planned					X		X			X	X			X			X									
	Accompl.					X		X				X			X			X									
3. Proj's	SP Work					X						X			X												
	Constr.							X										X									
4. AM	λ		6			6				56		56			6												
	Fo											9															
	S																										
	D																										
	MP																										
	F					3				3				63	3		6	7			6						
	G		56			56				56		56															
	DCO																								7		
	CMR																										
	BE Cards																										
	SLEM ADC												X		X												
	Gen's																										
	Other																										
ACTION:	Adj.											56			6a												
	Rep.					6						39			3												
5. Rect/Batt																											
6. Cables																											
	Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

Figure 3.8 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 01C   Period: 1 July - 31 December 1972

		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1. Progr.	SP	C	CS			C				CS				C				CS				C				CS	
	LP	C	S			C			C		S		C					C	C		C				C		
	SLEM		EM		E	M	E		E	M	E		E	M	E		E	M	E		E	M	E		E		E
2. Visits	Planned			X						X	X	X	X		X					X			X				
	Accompl.			X						X	X	X	X		X					X			X				
3. Proj's	SP Work																										
	Constr.									X	X	X	X		X												
4. AM	λ	7								47															7		
	Fo																						7				
	S	4																									
	D																										
	HP			8																							
	F					4				4																	
	G																										
	DCO																										
	CMR																										
	BE Cards																										
	SLEM ADC																										
	Gen's																										
	Other																			X							
ACTION:	Adj.			8						47																	
	Rep.									4													7				
5. Rect/Batt																											
6. Cables																											

Time (Week of Year) 1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

SA: 02C Period: 1 July - 31 December 1972

1. Progr.	SP		CS			C				S	C			C				CS				C		C		CS	
	LP	C	S			C		C	C		S			C			C		C		C				C		
	SLEM		ME		E	M	E		E	M	E		E		ME		E	M	E		E	M	E		E		E
2. Visits	Planned				X				X											X			X				
	Accompl.				X				X											X			X				
3. Proj's	SP Work								X														X				
	Constr.								X																		
4. AM	λ				7													5				5	5	5		5	
	Fo																	5				5	5	5		5	
	S																										
	D																										
	MP																										
	F																										
	G																						3				
	DCO		3		3																9						
	CMR																78 9						4				
	BE Cards																										
	SLEM ADC																										
	Gen's				X																						
	Other																			X			14*				
ACTION:	Adj.				37 9																		43				
	Rep.																						5				
5. Rect/Batt																											
6. Cables																											
Time (Week of Year) 1972				30					35					40					45					50			53

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

* Numbers refer to entry point in Table 3.10

Figure 3.10 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 03C Period: 1 July - 31 December 1972

1. Progr.	SP		SC								SC			C				SC				C				SC	
	LP										S	C		C			C		C		C				C		
	SLEM		EM		E						EM		E	M	E		E	M	E		E	M	E		E	M	E
2. Visits	Planned		X	X	X													X		X							
	Accompl.		X	X	X															X							
3. Proj's	SP Work																										
	Constr.																			X							
4. AM	λ			89																							
	Fo																										
	S																										
	D																										
	HP																										
	F		2	2							2			2				2				2				2	
	G		6																								
	DCC				78						7																
	CMR				89																						
	BE Cards																										
	SLEM ADC		X																								
	Gen's																						X		X		X
	Other																										
ACTION:	Adj.		6a	89																							
	Rep.			2																							
5. Rect/Batt				X	X																						
6. Cables																											
	Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

SA: 04C Period: 1 July - 31 December 1972

		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1. Progr.	SP		C				C			C	CS				C				S	C	C		C				CS
	LP			CS			C	C		C		S		C					C			C					
	SLEM		M	E		E	M	E		E	M	E		E	M	E		E	M	E		E	M	E		E	M
2. Visits	Planned		X				X		X									X			X						
	Accompl.		X				X		X												X						
3. Proj's	SP Work								X																		
	Constr.																										
4. AM	λ						15 7		15 7																		
	Fo																										
	S																										
	D																										
	MP																										
	F		46				54 6			5	1									35 6							
	G																										
	DCO																										
	CMR																										
	BE Cards		1-4 6																								
	SLEM ADC																										
	Gen's																	X			X						
	Other																										
ACTION:	Adj.						7		25 157																		
	Rep.		1-4 6				45 6														g						
5. Rect/Batt																											
6. Cables																											

Time (Week of Year) 1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

Figure 3.12 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 05C   Period: 1 July - 31 December 1972

1. Progr.	SP		CS								CS				C				CS		C	C	C				CS
	LP		C	S						C	S			C					C			C				C	
	SLEM		M	E		E	M	E		E	M	E		E	M	E		E	M	E		E	M	E		E	M
2. Visits	Planned		X						X	X	X				X				X	X	X	X			X		
	Accompl.		X						X	X	X				X				X	X	X	X			X		
3. Proj's	SP Work																										
	Constr.																										
4. AM	λ		89						89	9				9	9				3	7							
	Fo																								7		
	S																		3								
	D																										
	MP																										
	F																										
	G																										
	DCO																										
	CMR								4																		
	BE Cards		6																								
	SLEM ADC																										
	Gen's			X		X		X	X	X	X																
	Other									15*	15*				15*				15*	15* 17*	15*	15*					
ACTION:	Adj.								89 4						9					7							
	Rep.								g		g									3					7		
5. Rect/Batt																											
6. Cables																											
	Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

* Numbers refer to entry points in Table 3.10.

SA: 06C   Period: 1 July - 31 December 1972

		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1. Progr.	SP				C		C				CS					C			CS				C				CS
	LP					C				C		S		C				C				C				C	
	SLEM	E		E		E	M	E		E	M	E		E		E		E	M	E		E		EM		E	M
2. Visits	Planned		X						X						X					X			X		X		
	Accompl.		X						X						X					X			X		X		
3. Proj's	SP Work								X																		
	Constr.																						X				
4. AM	λ								8											7							
	Fo																								9		
	S																										
	D																										
	MP																										
	F															1			1	1							
	G																										
	DCO														3												
	CMR									2		2		2	2								4				
	BE Cards		45 6																								
	SLEM ADC		X																								
	Gen's	X	X																					X		X	
	Other																						14*				
ACTION:	Adj.		a						8						2					7			4				
	Rep.		45 6 g												3					1					9		
5. Rect/Batt																											
6. Cables																											

Time (Week of Year) 1972

CODES:

Programs:

- C - CHANEV
- S - SACP
- M - MISNO
- E - SLEMTEST

Hardware/SLEM:

- e - EPU
- a - RSA/ADC
- g - Test generators
- m - Main data cable
- p - Power cable

* Numbers refer to entry point in Table 3.10

Figure 3.14 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 07C Period: 1 July - 31 December 1972

		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1. Progr.	SP		CS				C				CS					C			CS				C				CS
	LP		C	S		C					C	S		C				C				C				C	
	SLEM	E		EM		E	M	E		E	M	E		E	M	E		E	M	E		E	M	E		E	M
2. Visits	Planned								X			X													X		
	Accompl.								X			X													X		
3. Proj's	SP Work																										
	Constr.																										
4. AM	λ		7			7			7																		
	Fo																										
	S																										
	D																										
	MP																										
	F																										
	G						3																				
	DCO																										
	CMR								1																		
	BE Cards								3																		
	SLEM ADC								X																		
	Gen's	X		X		X		X																			
	Other																								X		
ACTION:	Adj.								17 9a																		
	Rep.								3																		
5. Rect/Batt									X			X															
6. Cables																											

Time (Week of Year) 1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

SA: 08C Period: 1 July - 31 December 1972

1. Progr.	SP		CS				C				CS					C			CS				C				CS
	LP		C	S			C			C		S		C				C				C				C	
	SLEM	E		ME		E	M	E		E	M	E		E	M	E		E	M	E		E		E		E	M
2. Visits	Planned				X	X				X	X		X	X	X	X											
	Accompl.				X	X				X				X		X											
3. Proj's	SP Work					X				X																	
	Constr.															X											
4. AM	λ		5			5	5			5	5			5													
	Fo					9				9						7											
	S		5																								
	D																										
	MP																										
	F		7			5																					
	G		78				78			78				78													
	DCO													7													
	CMR																										
	BE Cards																										
	SLEM ADC				X																					X	
	Gen's																										
	Other					7																					
ACTION:	Adj.				a	5				59				57 8													
	Rep.					97 5										7											
5. Rect/Batt						X																					
6. Cables																											
	Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

Figure 3.16 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 09C Period: 1 July - 31 December 1972

1. Progr. SP		SC				C			C	SC								SC				C				SC
LP		C	S		C					C	S		C				C				C				C	
SLEM	E		EM		E	M	E		E		EM		E		E		E	M	E		E	M	EM		E	M
2. Visits Planned	X		X		X		X	X		X			X	X												
Accompl.	X		X		X		X	X						X												
3. Proj's SP Work	X						X	X																		
Constr.			X					X						X												
4. AM λ						5		5										1				1				1
Fo	1																									
S						1			1	1				1												
D																										
MP																										
F																		3								
G		1	1				1							2												
DCO																										
CMR														56												
BE Cards																										
SLEM ADC	X		X		X		X		X		X															
Gen's																										
Other																										
ACTION: Adj.			1		a		al	5						25 6												
Rep.	1													1												
5. Rect/Batt					X			X																		
6. Cables																										
Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

SA: 10C Period: 1 July - 31 December 1972

1. Progr.	SP			CS						C	SC					C				CS		C		C			
	LP			S	C	C					S		C				C					C				C	
	SLEM	E		ME		E		E	M	E	ME		E			ME	E			ME		E		ME		E	
2. Visits	Planned	X		X				X	X		X										X						
	Accompl.	X		X				X	X		X										X						
3. Proj's	SP Work																										
	Constr.								X																		
4. AM	λ			78 9	86	8		8																1			
	Fo							1																			
	S				1																						
	D																										
	MP																										
	F									25																	
	G										5										6	2		2		2	
	DCO									78 9											1						
	CMR								6												3						
	BE Cards			6				24 5	13 45																		
	SLEM ADC																										
	Gen's			X							X																
	Other	16*																									
ACTION:	Adj.			78 9				8	6		5										36						
	Rep.			g6				24 51	13 45		g										1						
5. Rect/Batt		X																									
6. Cables																m											
	Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable
* Numbers refer to entry point in Table 3.10

Figure 3.18 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 11C Period: 1 July - 31 December 1972

1. Progr.	SP			SC				C				SC				C				SC				C			
	LP		C	S		C				C		S		C								C					C
	SLEM	E		EM		E		EM		E		EM		E		EM		E		EM		E		EM		E	
2. Visits	Planned	X				X		X	X						X			X	X		X						
	Accompl.	X						X	X						X						X						
3. Proj's	SP Work	X																									
	Constr.								X																		
4. AM	λ		78			78		78		78					978									3			
	Fo	1																									
	S																							3			
	D			6																							
	MP																										
	F			4				64								6								4			
	G	12		5		5		5				12							3		3			3		3	
	DCO	16																									
	CMR																										
	BE Cards	14 56						5																			
	SLEM ADC																										
	Gen's																										
	Other																										
ACTION:	Adj.	12						57 8							78 9						3						
	Rep.	14 56						45																			
5. Rect/Batt		X						X																			
6. Cables																											
Time (Week of Year)				30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

SA: 12C Period: 1 July - 31 December 1972

1. Progr.	SP			CS				C		C		CS				C				S	C			C			
	LP			SC		C					C	S		C				C				C				C	
	SLEM	E		EM		E		EM		E		EM		E		EM		E		EM		E		EM		E	
2. Visits	Planned	X	X		X			X		X	X						X				X						
	Accompl.	X	X		X			X		X	X						X				X						
3. Proj's	SP Work	X																									
	Constr.									X																	
4. AM	λ	89		389	89			38			8			8			8				3			3			
	Fo																										
	S			8							8			8				8				8				8	
	D	4																									
	MP																										
	F			1																	2			2			
	G	3	3	39				38								3					43						
	DCO	5	5				2	27 89			5													1		1	
	CMR									12	12 8			2		2	2				1						
	BE Cards	34 6			23																						
	SLEM ADC																										
	Gen's	X	X																								
	Other				11*																						
ACTION:	Adj.	894 34	53		89			9 87			12 58						8				14						
	Rep.	346	9		23			2									2										
5. Rect/Batt					X																						
6. Cables																											
	Time (Week of Year)			30					35					40					45					50			53

1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

* Numbers refer to entry point in Table 3.10

Figure 3.20 SUBARRAY HISTORY - Array Monitoring Disclosures

SA: 13C Period: 1 July - 31 December 1972

		27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1. Progr.	SP			SC				C	C		C	SC				C				SC				C			
	LP		C	S							C	S		C				C				C				C	
	SLEM	E		EM		E		EM		E		EM		E		EM		E		EM		E		EM		E	
2. Visits	Planned					X	X	X		X	X																
	Accompl.						X	X		X	X																
3. Proj's	SP Work							X																			
	Constr.									X																	
4. AM	λ		7	4				47																4			
	Fo																										
	S																										
	D																										
	MP																										
	F										15																
	G										1													3		7	
	DCO	4		4		4		4			3											3		3			
	CMR																										
	BE Cards																										
	SLEM ADC																										
	Gen's										X																
	Other																										
ACTION:	Adj.							47			3																
	Rep.										15 g																
5. Rect/Batt								X																			
6. Cables							4																				

Time (Week of Year): 30, 35, 40, 45, 50, 53 — 1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

SA: 14C   Period: 1 July - 31 December 1972

		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1. Progr.	SP			CS				C				CS				C				CS				C			
	LP		C	S		C				C		S			C			C				C				C	
	SLEM	E		ME		E		ME		E		ME		E		ME		E		ME		E		ME		E	
2. Visits	Planned				X	X	X			X	X	X			X			X									
	Accompl.				X					X	X	X			X			X									
3. Proj's	SP Work											X															
	Constr.									X								X									
4. AM	λ		7					5		78 9	78 9	5															
	Fo																										
	S																										
	D																										
	MP																										
	F										3	4				4		4		4				4			
	G											5			5	5											
	DCO			4		4		4		4		4															
	CMR											4															
	BE Cards																										
	SLEM ADC																										
	Gen's																										
	Other				18*																						
ACTION:	Adj.										78 9	45			5			4									
	Rep.										3																
5. Rect/Batt																											
6. Cables																											

Time (Week of Year): 30, 35, 40, 45, 50, 53 — 1972

CODES:

Programs:

C - CHANEV
S - SACP
M - MISNO
E - SLEMTEST

Hardware/SLEM:

e - EPU
a - RSA/ADC
g - Test generators
m - Main data cable
p - Power cable

*Numbers refer to entry point in Table 3.10

Figure 3.22 SUBARRAY HISTORY - Array Monitoring Disclosures

3.2.2 Discussion

3.2.2.1 Subarray Monitoring Schedule

Figures 3.1-3.22, part 1. Progr., show that the planned schedule for the remote array monitoring has been well met. In the few cases where the monitoring routine has been interrupted, the reasons have been cancellations of the AM program in question at signal insertion points on all or most of the subarray's data channels, NDPC/NORSAR communication problems or cable breakages. The cancellations of the programs are not fully understood, but hardware troubles such as degraded performance of the test signal generator and relays or computer under- or overflow in the arithmetic calculations during the analysis of the acquired data base explain a large number of the cases.

3.2.2.2 Maintenance Visits

The objectives of subarray visits - not to mention the corrective maintenance - have been the accomplishment of tasks related to preventive maintenance (see Section 3.2.2.3), and repair of data and power cables (see Section 3.2.2.6).

Figure 3.23 shows the number of visits to the different subarrays in the period. Excluding visits caused by troubles in the communications system, 15 of the subarrays - subarrays 04B-06B, 01C, 05C, 09C and 12C not included - have in average been visited 5.6 times. This is a reasonable number compared with the number of visits from last period. The average then was 9.5 times in nine months for most of the subarrays. The same number for the subgroup - 05B still excluded - is 10. However, an investigation of the tasks accomplished at these seven subarrays discloses that the difference is not caused by more

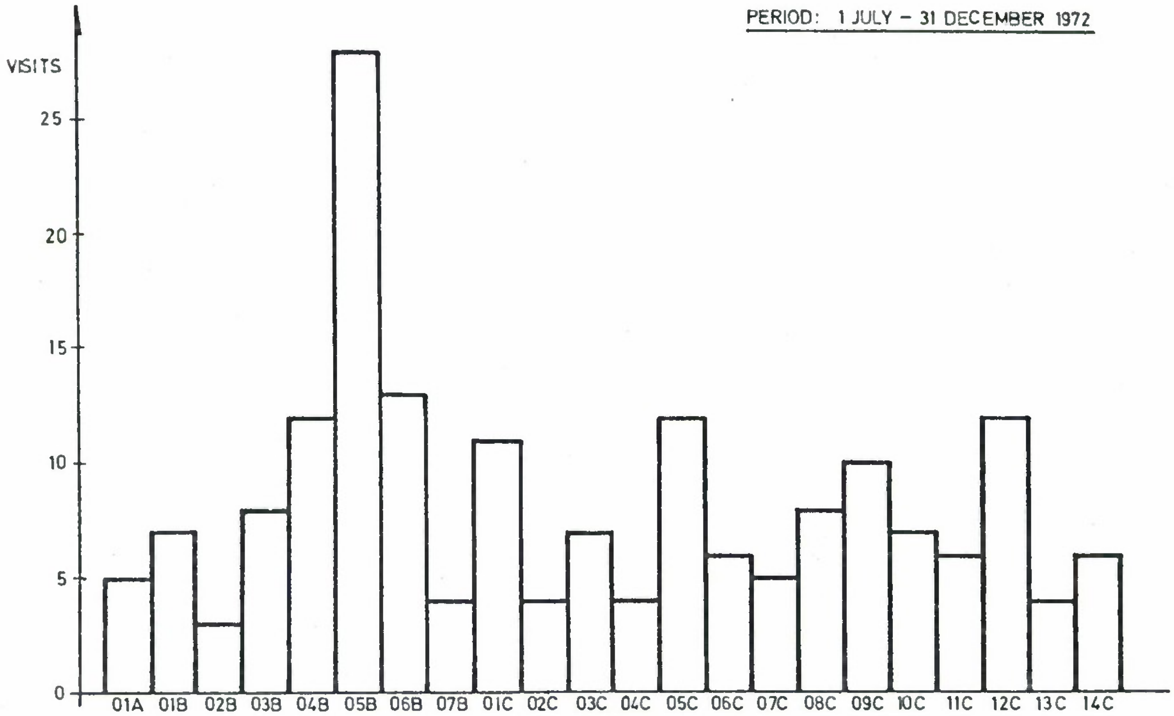

Figure 3.23 Number of Maintenance Visits to the NORSAR Subarrays. (Visits caused by faults in the NORSAR/NDPC Communication System are not included.)

maintenance due to a significantly greater instability in operating parts or a more frequent degrading of performance compared with the others. For the most part the difference in number of visits to this subgroup and the rest of the array is explained by preventive maintenance of the CTV/LPV facilities (accomplished at 04B-06B, 01C-02C, 06C and 08C-14C), installation of NAS (at 05C) and a large number of cable breakages - especially 05B. The discrepancy between subarrays of the subgroup and the rest of the array is explained in more detail in Table 3.2.

Sub-array	No. of Visits[1] (Fig. 3.23)	Maintenance visits on: Cable break-ages	CTV/LPV Constr.	"Normal" Maint.	Other Maint.	Comments
04B	12	4	3	2	3*	*Seismic data degraded by undefined noise source (hardware)
05B	28	20	1	7		Local cable hunting season
06B	13		4	6	3*	*Replacement & Check of RA-5 due to CHANEVSP cancel.
01C	11		7	4		Extensive preparations for the CTV/LPV work requested
05C	12			3	9*	*Installation & calibr. of analog station
09C	10		3	7		4 visits: SP work 3 visits: RSA/ADC faults
12C	12		1	11		1 visit: SP work 1 visit: Faulty test generator 2 visits: Damaged BE-cards 3 visits: Gain/DCO/CMR out-of-tol. 4 visits: LTA faulty

[1] Visits caused by communications faults are not included

TABLE 3.2

Tasks accomplished at 04B-06B, 01C, 05C, 09C and 12C.

3.2.2.3 Preventive Maintenance Projects

The task of SP seismometers having characteristics outside tolerance limits has continued, resulting in replacement of 10 seismometers. At the end of the year 6 sensors are still outside limits. The reviewing of the characteristics of the SP sensors which was initiated in the fall 1971 should then be completed. The status of SP sensor characteristics, damping and natural frequency at the end of the year is given in Figure 3.24. Work accomplished as part of the preventive maintenance of NORSAR as defined in Section 3.2.1 is given in Table 3.3. Table 3.5 gives the values of the damping resistance, R_d, of the SP seismometers.

Action	Unit	No. of Channels/ Subarrays		Channels	Comments
		Accompl.	Remaining		
Modification of RA-5 input card	RA-5	102 2)	30 1)	Ref. Table 3.5	Prototype card installed at 04B and 06C (06C03 excluded)
Replacement due to λ, F_o	Seism	10	6	Refer Table 3.4 and Figs 3.1-3.22	
Construction work	CTV/ LPV	13	0	-	04B-06B, 01C, 02C 06C, 08C-14C
Construction work	WHV	4		-	06C03, 04, 09C04, 06

1) Nine of these are modified for noise suppression but variable R_d is lacking.

2) Modifications performed during both 1972^{I} and 1972^{II}

TABLE 3.3

Preventive Maintenance of NORSAR accomplished in the period

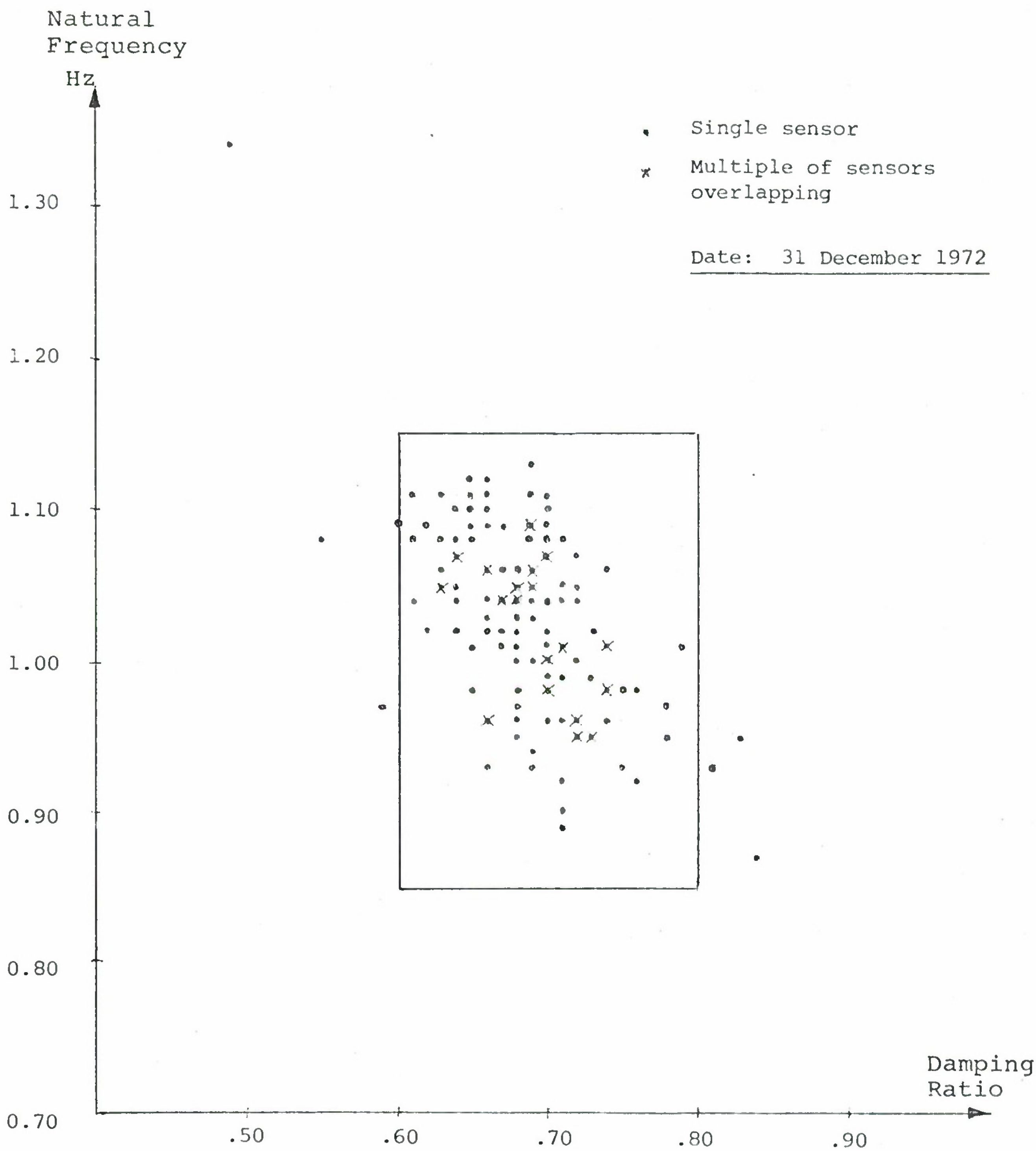

Figure 3.24 Damping and Natural Frequency of SP Seismometers (see Table 3.4)

SA	Chan	Damping Ratio	Natural Frequency	Date Measured
01A	01	0.62	1.09	12/16
	02	0.71	1.04	
	03	0.70	1.08	
	04	0.72	1.05	
	05	0.68	1.05	
	06	0.70	1.02	
01B	01	0.66	1.11	12/16
	02	0.68	0.95	
	03	0.63	1.11	
	04	0.71	0.90	
	05	0.71	0.99	
	06	0.63	1.05	
02B	01	0.68	1.00	12/19
	02	0.66	1.09	
	03	0.70	1.11	
	04	0.66	1.10	
	05	0.69	1.13	
	06	0.70	0.98	
03B	01	0.66	1.06	12/16
	02	0.71	0.96	
	03	0.70	1.07	
	04	0.71	1.01	
	05	0.67	1.01	
	06	0.70	0.98	
04B	01	0.68	1.06	12/16
	02	0.73	0.99	
	03	0.68	0.97	
	04	0.75	0.93	
	05	0.73	1.05	
	06	0.70	0.98	
05B	01	0.74	0.98	12/16
	02	0.69	1.00	
	03	0.63	1.08	
	04	0.64	1.10	
	05	0.67	1.04	
	06	0.70	1.00	

TABLE 3.4

Natural Frequency and Damping Ratio –
31 December 1972

SA	Chan	Damping Ratio	Natural Frequency	Date Measured
06B	01	0.74	1.01	12/23
	02	0.68	0.98	10/19
	03	0.69	1.04	12/23
	04	0.70	1.10	12/23
	05	0.70	1.07	12/23
	06	0.68	1.04	12/23
07B	01	0.65	1.10	12/23
	02	0.68	1.05	
	03	0.69	0.94	
	04	0.66	1.12	
	05	0.71	0.89	
	06	0.64	1.04	
01C	01	0.70	1.00	12/23
	02	0.70	0.96	
	03	0.66	0.96	
	04	0.65	0.98	
	05	0.67	1.02	
	06	0.69	1.06	
02C	01	0.64	1.05	
	02	0.68	1.04	
	03	0.68	1.03	
	04	0.78	0.95	
	05	0.49*	1.34*	
	06	0.74	1.01	
03C	01	0.70	1.00	12/23
	02	0.72	0.95	
	03	0.66	1.03	
	04	0.64	1.08	
	05	0.72	0.96	
	06	0.72	0.96	
04C	01	0.65	1.01	12/27
	02	0.73	1.02	
	03	0.66	1.02	
	04	0.70	0.99	
	05	0.63	1.05	
	06	0.71	1.00	

* Outside tolerance limits

TABLE 3.4 (cont.)

Natural Frequency and Damping Ratio -
31 December 1972

SA	Chan	Damping Ratio	Natural Frequency	Date Measured
05C	01	0.72	1.00	12/27
	02	0.60	1.09	
	03	0.78	0.97	
	04	0.67	1.04	
	05	0.63	1.05	
	06	0.73	0.95	
06C	01	0.71	0.92	12/27
	02	0.72	1.07	
	03	0.79	1.01	
	04	0.72	1.04	
	05	0.69	1.11	
	06	0.68	1.05	
07C	01	0.66	0.93	12/27
	02	0.75	0.98	
	03	0.69	1.05	
	04	0.74	1.06	
	05	0.71	1.08	
	06	0.72	0.96	
08C	01	0.69	1.09	12/27
	02	0.71	1.01	
	03	0.67	1.06	
	04	0.72	0.96	
	05	0.63	1.06	
	06	0.69	1.06	
09C	01	0.55*	1.08	12/27
	02	0.61	1.11	
	03	0.65	1.12	
	04	0.76	0.98	
	05	0.67	1.08	
	06	0.72	0.95	
10C	01	0.84*	0.87	12/07
	02	0.65	1.11	
	03	0.61	1.04	
	04	0.74	0.98	
	05	0.70	1.09	
	06	0.62	1.02	

* Outside tolerance limits

TABLE 3.4 (cont.)

Natural Frequency and Damping Ratio -
31 December 1972

SA	Chan	Damping Ratio	Natural Frequency	Date Measured
11C	01	0.64	1.07	12/07
	02	0.65	1.08	
	03	0.83*	0.95	
	04	0.66	1.06	
	05	0.66	1.04	
	06	0.65	1.09	
12C	01	0.76	0.92	12/07
	02	0.69	1.08	
	03	0.59*	1.07	
	04	0.70	1.04	
	05	0.68	0.96	
	06	0.61	1.08	
13C	01	0.68	1.01	12/07
	02	0.69	0.93	
	03	0.71	1.05	
	04	0.81*	0.93	
	05	0.64	1.07	
	06	0.68	1.02	
14C	01	0.64	1.02	12/07
	02	0.69	1.02	
	03	0.69	1.05	
	04	0.69	1.09	
	05	0.66	0.97	
	06	0.74	0.96	

* Outside tolerance limits

TABLE 3.4 (cont.)

Natural Frequency and Damping Ratio -
31 December 1972

Sub-array	Damping Resistance R_d (kΩ)					
	Seismometer					
	00/06	01	02	03	04	05
01A	250	280	X	220	180	X
01B	X	X	X	X	X	240
02B	X	240	X	230	210	200
03B	205	X	X	205	X	X
04B	255	255	295	240	320	231
05B	X	X	240	X	X	X
06B	240	240	240	230	200	200
07B	200	240	240	290	210	280
01C	205	250	210	280	215	240
02C	215	X	X	240	300	240
03C	290	XX	XX	200	240	XX
04C	220	215	205	200	215	210
05C	240	200	240	210	275	205
06C	240	200	215	240	200	200
07C	270	220	245	250	200	200
08C	190	190	190	230	240	215
09C	X	240	240	240	215	215
10C	XX	240	240	XX	XX	200
11C	XX	180	280	XX	XX	240
12C	210	180	215	215	240	XX
13C	242	205	240	215	210	265
14C	300	180	190	200	240	240

Codes: X - Modified RA-5 input card with variable R_d not installed (R_d = 240 kΩ)

XX - Modified RA-5 input card without variable R_d installed (R_d = 240 kΩ)

TABLE 3.5

Damping Resistance, R_d, of SP Sensors as of 31 December 1972

3.2.2.4 Disclosed Malfunctions - Instrumentation and Electronics

Figures 3.25 - 3.32 show the disclosed malfunctions and accomplished adjustments and replacements of field equipment with reference to the faulty channel characteristics and channel. Table 3.6 gives the number of faults in the total array classified as in Figures 3.25 - 3.32 by the involved characteristics and unit in question.

System	Action	Seismometer				RCD (LP only)	Amplifiers			LTA				BE Card	SLEM				E
		λ	F_o	S	D		G	D	B	G	F	DCO	CMR		Generators BB	Generators SP	Generators LP	ADC	
SP	Adjusted	11	-	-	-		6	-	1	38	-	6	21		2	1	2	9	
	Replaced	2	6	2	-		1	-	-	-	13	4	1	33	9	6	1	-	
LP	Adjusted	42	-	-	-	4	-	-		8	-	4	2						
	Replaced	-	-	-	-	9	-	-		-	2	-	-						

TABLE 3.6

Number and types of necessary adjustments/replacements in the period (see also Table 3.10). Parameter codes are explained in Table 3.1.

Sub-array	Ch	Seismometer λ	Seismometer Fo	Seismometer S	Seismometer D	Seismometer Misc	Amplifier G	Amplifier D	Amplifier B	Amplifier Misc	LTA G	LTA F	LTA DCO	LTA CMR	BE card	SLEM Generators BB	SLEM Generators SP	SLEM Generators LP	SLEM ADC	SLEM EPU	SLEM DU
01A	1											R	a						A		
	2												a								
	3										Aa		a								
	4										aAa		a								
	5										AA		a								
	6												a								
	V	AA																			
	NS	AA				5*															
	EW																				
01B	1										AA		a								
	2										a		A								
	3										a		a								
	4										aa		a								
	5	R					A						A								
	6												a								
	V	A	A								A										
	NS		AA			1,1,4*					a										
	EW																				
02B	1															a					
	2																				
	3												a	a							
	4																				
	5													A							
	6													a							
	V		A			2								A							
	NS	A												A							
	EW	A				21															

Codes:
- A - requested adjustment
- a - non-critical adjustment (routine procedure)
- R - replacement
- / - adjacent code refers to new unit after replacement

1 - faulty RCD repaired at site
2 - RCD replaced

FIGURE 3.25

Adjustments and replacements performed in the array by the field technicians. (Cable, modem and rectifiers repairs not included.)
Parameter codes are explained in Table 3.1.
*Number refers to entry point in Table 3.10 (Section [illegible]

Period: 1 July - 31 December 1972

Sub-array	Ch	Seismometer					Amplifier				LTA				BE card	SLEM					
																Generators			ADC	EPU	DU
		λ	Fo	S	D	Misc	G	D	B	Misc	G	F	DCO	CMR		BB	SP	LP			
03B	1										aA		a	A							
	2										a		A								
	3										Aa		a								
	4										aA		Aa								
	5										a	6*		a							
	6										Aa			A							
	V										a										
	NS																				
	EW					2					a										
04B	1												a							R	R
	2										AA										
	3										aA										
	4										A										
	5										A										
	6								a												
	V																				
	NS																				
	EW	AA									A										
05B	1										a		a			A			A	A	
	2	a					aa		aa	7*	aa		a	A		R	R		A		
	3		R								aA		aa			R	R	R			
	4					8*9*					aA		aa		R	a					
	5										a		aa			a					
	6		R								aA		a	A	R						
	V										a										
	NS										a		a								
	EW										a		a								

Codes: A - requested adjustment
a - non-critical

1 - faulty RCD repaired at site
2 - RCD replaced

FIGURE 3.26

Adjustments and replacements performed in the array by the

Sub-array	Ch	Seismometer					Amplifier				LTA				BE card	SLEM					
																Generators			ADC	EPU	DU
		λ	Fo	S	D	Misc	G	D	B	Misc	G	F	DCO	CMR		BB	SP	LP			
06B	1												aa	A		R	R			R	
	2									10* 10*	aa	R	a	a	R			A			R
	3										a		aaa	AA				A			
	4										a										
	5												a		R						
	6										aAa		aaa								
	V	A											a								
	NS												a								
	EW												a								
07B	1										a		aa						a		
	2												aa								
	3											RR	a								
	4												a								
	5	a					A				A		a								
	6	a/a	R				A		a		Aa										
	V												a								
	NS												a								
	EW					2							a								
01C	1												a								
	2										A		a								
	3																				
	4	A										R									
	5												a								
	6																				
	V	A	A			2					a										
	NS					1															
	EW																				

Codes: A - requested adjustment
a - non-critical adjustment (routine procedure)
R - replacement
/ - adjacent code refers to new unit after replacement

1 - faulty RCD repaired at site
2 - RCD replaced

FIGURE 3.27

Adjustments and replacements performed in the array by the field technicians. (Cable, modem and rectifiers repairs not included.)

Parameter codes are explained in Table 3.1.

*Number refers to entry point in Table 3.10 (Section 3.2.3)

Period: 1 July - 31 December 1972

Sub-array	Ch	Seismometer λ	Seismometer Fo	Seismometer S	Seismometer D	Seismometer Misc	Amplifier G	Amplifier D	Amplifier B	Amplifier Misc	LTA G	LTA F	LTA DCO	LTA CMR	BE card	SLEM Generators BB	SLEM Generators SP	SLEM Generators LP	SLEM ADC	SLEM EPU	SLEM DU
02C	1												aa				A				
	2												a								
	3										A		Aa								
	4												a								
	5		R				a						a								
	6												a	A							
	V	A																			
	NS																				
	EW																				
03C	1												a				R		A A		
	2											R	a								
	3												a								
	4												a								
	5										a		a								
	6										A		a								
	V																				
	NS												a								
	EW	A																			
04C	1	A									aA		a		R	R					
	2										aA		a		R						
	3										a				R						
	4										a	R			R						
	5	A									aA		aa								
	6										a	R	a		R						
	V	AA									A										
	NS																				
	EW										A										

Codes: A - requested adjustment
a - non-critical

1 - faulty RCD repaired at site
2 - RCD replaced

FIGURE 3.28

Adjustments and replacements performed in the array by the

Sub-array	Ch	Seismometer					Amplifier				LTA				BE card	SLEM					
																Generators			ADC	EPU	DU
		λ	Fo	S	D	Misc	G	D	B	Misc	G	F	DCO	CMR		BB	SP	LP			
05C	1										a		aa			R					
	2										a		aa				R				
	3					8*					a		aa								
	4										a		aa	A							
	5												aa								
	6												aa		R						
	V	A	A			2					a										
	NS	A																			
	EW	AA																			
06C	1										A	R	a	a		R			a	A	
	2										a		a/a	A							
	3												aR	/a							
	4												a		R						
	5												a		R						
	6												a		R						
	V	A									A										
	NS	A																			
	EW		A			2															
07C	1												a	A		A			A		
	2																				
	3										A		a		R						
	4										a		a								
	5												a								
	6												a								
	V	A																			
	NS					3 *							a								
	EW												a								

Codes:
- A - requested adjustment
- a - non-critical adjustment (routine procedure)
- R - replacement
- / - adjacent code refers to new unit after replacement

1 - faulty RCD repaired at site
2 - RCD replaced

FIGURE 3.29

Adjustments and replacements performed in the array by the field technicians. (Cable, modem and rectifiers repairs not included.)

Parameter codes are explained in Table 3.1.

*Number refers to entry point in Table 3.10

Period: 1 July - 31 December 1972

Sub-array	Ch	Seismometer					Amplifier				LTA				BE card	SLEM					
																Generators			ADC	EPU	DU
		λ	Fo	S	D	Misc	G	D	B	Misc	G	F	DCO	CMR		BB	SP	LP			
08C	1												aa						A		
	2												a								
	3												a								
	4												a								
	5	ARAA					a						aa								
	6												a								
	V					2					A	R	A								
	NS										A	R	a								
	EW					2							a								
09C	1	/A	R	/R			a		a		AA		a						AA		
	2										A		a						a		
	3												a								
	4										a		a								
	5	A							a		A			A							
	6													A							
	V																				
	NS																				
	EW																				
10C	1			R									R		R		R				
	2														R	R					
	3										aa		a	aA	R						
	4												aa		RR						
	5										A		aa	A	RR						
	6										aA			A	R						
	V	A											a								
	NS	AA											aa								
	EW	A											aa								

Codes: A - requested adjustment
a - non-critical

1 - faulty RCD repaired at site
2 - RCD replaced

FIGURE 3.30

Adjustments and replacements performed in the array by the

Sub-array	Ch	Seismometer λ	Seismometer Fo	Seismometer S	Seismometer D	Seismometer Misc	Amplifier G	Amplifier D	Amplifier B	Amplifier Misc	LTA G	LTA F	LTA DCO	LTA CMR	BE card	SLEM Generators BB	SLEM Generators SP	SLEM Generators LP	SLEM ADC	SLEM EPU	SLEM DU
11C	1		R								Aa		Aaa		R					R	
	2										Aa		aa	a							
	3										A		aa								
	4											R	aa	a	R						
	5	a					RA				aa		a		RR						
	6										a		Raa		R						
	V	AA									a										
	NS	AA																			
	EW	A																			
12C	1										a		aaa aa	AA		R					
	2										aa	11*	aaRa	AR	R						
	3	aA					aA				a		aaaa a		RRR						
	4						A		A		a		aaa		R						
	5										a		Aaaa a aa								
	6						a				a		aaaa		R						
	V										aa		Aa								
	NS	AAAA A									Aaa		Aa								
	EW	AA									aaa		Aa								
13C	1											R				R					
	2																				
	3												a								
	4	A											a								
	5											R									
	6																				
	V	A											a								
	NS										aa										
	EW										aa										

Codes:
- A - requested adjustment
- a - non-critical adjustment (routine procedure)
- R - replacement
- / - adjacent code refers to new unit after replacement

1 - faulty RCD repaired at site
2 - RCD replaced

FIGURE 3.31

Adjustments and replacements performed in the array by the field technicians. (Cable, modem and rectifiers repairs not included.)

Parameter codes are explained in Table 3.1.

*Number refers to entry point in Table 3.10 (Section 3.2.2)

Period: 1 July - 31 December 1972

Sub-array	Ch	Seismometer					Amplifier				LTA				BE card	SLEM					
																Generators			ADC	EPU	DU
		λ	Fo	S	D	Misc	G	D	B	Misc	G	F	DCO	CMR		BB	SP	LP			
14C	1										a		a			a					
	2										a										
	3										a		/a								
	4											/R	R	A							
	5	A									A										
	6																				
	V	A											a								
	NS	A											a								
	EW	A											a								

Codes: A - requested adjustment
a - non-critical adjustment (routine procedure)

1 - faulty RCD repaired at site
2 - RCD replaced

FIGURE 3.32

Adjustments and replacements performed in the array by the field technicians (Cable, modem and rectifiers repairs

3.2.2.5 Rectifiers/batteries

Only 3 malfunctions on the rectifiers or batteries have been reported. Table 3.7 identifies the subarrays where the faults occurred and a description of these.

Subarray	Fault	Period of Inoperation	Comments
03C, 07C 11C	Timer relay (V25-0261) faulty (coil defect)	No interruption	Charger permanently in "high charge" mode

TABLE 3.7

Faults Disclosed in Subarray Rectifiers

3.2.2.6 Cables

Cable breakages have been numerous considering the length of the period. Table 3.8 shows the channels affected and the time elapsed before repairs were accomplished.

Sub-array	WHV Cable	Main Data Cable	Breakage (out of operation) From date	To date	No. of days' work
05B	02		9 June	10 August	11
	06		3 August	4 August	2
	02		18 September	16 October	18
	01		16 October	18 October	2
		x	25 October	26 October	*
	05		20 October	2 November	3
	02,03,06		2 November	7 November	4
13C	04		7 August	9 August	4
04B	02		1 September	13 October	5
01A	05	x	20 September	10 October	4 and *
	05	x	28 October	30 October	*
10C		x	6 October	12 October	*
* Repaired by NTA					

TABLE 3.8

Cable Breakages

3.2.2.7 NORSAR/NDPC Communication System

A total of nine subarrays (see Table 3.9) have been visited due to malfunctions of modems or telephone lines. The field technicians performed a total of 38 days' work in the field for this task. This work is documented in (2).

Subarray	01A	01B	02B	03B	04B	05B	06B	07B	01C	02C	03
No. of Visits			1	3			2				7
No. of days' work			1	3			4				8

Subarray	04C	05C	06C	07C	08C	09C	10C	11C	12C	13C	14
No. of Visits	1		2				1	7		4	
No. of days' work	1		2				2	12		5	

TABLE 3.9

Subarray Visits
caused by Faults in the Communication System

3.2.3 Miscellaneous Maintenance

Maintenance tasks which were of a non-general type are listed in Table 3.10. Besides, to simplify the access to the CTVs in subarrays 01A-07B, the CTV entrance doors were redesigned to be compatible with the CTV doors in the outer ring.

Sub-array	Entry Point 1)	Action		Symptom	Comment
		Repaired/ Adjusted	Replaced		
07C	3		x	MP outside tolerances and unadjustable	MP lamp bulb replaced
01B	4		x	NS LP sensor phase inverted	Faulty magnetization of magnets (installed May 71)
01A	5	x		NS LP sensor	Glass insulation dust removed from data coil
03B	6		x	Non-seismic noise on data ch. 05	LTA replaced
05B	7		x	Distortion of ch. 02	RA-5 battery power low
	8		x	No output on ch. 04	Faulty seism. cable
	9		x	Unable to calibrate ch. 04 sensor	Defect Calibration coil
06B	10		x	Unable to calibrate RA-5 on ch. 02	Replaced twice, no hardware failure disclosed
05C	17		x	Noisy data on ch. 03	Faulty seism. cable
12C	11		x	Calibration signals overlayed SP-data without NDPC request	Faulty relay K2 at LTA 02 caused induction between LP and SP channels

1) Refer numbers with asterisks in Figures 3.1 - 3.22 and 3.25-3.32

TABLE 3.10

Miscellaneous Maintenance

Sub-array	Entry Point 1)	Action		Symptom	Comment
		Repaired/ Adjusted	Replaced		
03B	12			-	Frequency response of RA-5 and LTA measured on all SP channels
04B	13		x	Seismic data degraded by undefined noise source (hardware)	DU and EPU replaced
02C/ 06C	14				Scaling circuits Z9, Z10, Z11 and Z12 were measured to control initial setting
05C	15				Installation and calibration of analog station
10C	16	x		No seismic data from subarray	Lightning released 5A and and 16A fuses in rectifier
14C	18			Noise on SP data	Cause not identified
01C	19				LP NS sensor output inverted week 27-38 due to faulty correction of interchanged EW NS sensor discovered last period

1) Refer to numbers with asterisks in Figures 3.1-3.22 and 3.25-3.32.

TABLE 3.10 (cont.)
Miscellaneous Maintenance

3.2.4 Work Shop Repairs

Faulty units and parts removed from the array and repaired at FMC are listed in Table 3.11.

Subarray	Unit/Channel	Week Removed	Index No.		Symptom	Parts Affected/ Repair
			S/N	USP		
01A	LTA 01/02	40	5260	-	Ripple ch. 01	At FMC - unrepaired
01B	Seism. 05	29	536	0383	2,5 V 50 Hz noise	Ready for final check at FMC
02B	FP RCD EW	31	290	-	Immovable	Complete overhaul & check
	FP RCD V	51	325	-	Immovable	At FMC unrepaired
03B	LTA 05/06	29	5117	-	Noise Ch 05	At FMC -unrepaired
	MP RCD EW	36	333	-	Immovable	Complete overhaul & check
	CK-card Modem	41	6674	-	B-loop failure	Replaced Y1 & Y3
	Line unit Modem	41	6676	-	No output	Replaced relay K1
04B	EPU	42	24	1842	Noisy	Replaced FD111
05B	Seism. 03	28	445	-	Freq. & damping out-of-tol.	At FMC unrepaired
	Seism. 00	28	380	-	Freq. & damping out-of-tol.	Freq. adjusted
	Seism. 00	29	505	0368	Cable failure	Replaced cable
	RA-5 02	33		0518	Distortion	At FMC unrepaired
	Seism. 04	43	523	0387	Faulty cable	Replaced cable. Ready for freq. adjustment
	Seism. 04	44	289	0441	Cal.coil defect	At FMC unrepaired
	Test Gen. Card	45	5196	-	± BB unstable. 1 Hz clipped	At FMC unrepaired
06B	RA-5 02	37		0498	CHANEV SP cancelled	At FMC unrepaired
	RA-5 02	37		0485	CHANEV SP cancelled	RA-5 tested at FMC and is o.k.
	LTA 01/02	44	5199	-	Ripple Ch 02	At FMC not repaired
	Digital unit	47	24	1840	ICW sync/poly failure	At FMC not repaired
07B	Seism. 00	32	345	-	Frequency out-of-tolerance	Adjusted & checked
	FP RCD EW	38	260	-	Immovable	Complete overhaul & check
	LTA 03/04	38	5229	-	Ripple Ch 03	At FMC not repaired
	LTA 03/04	41	5227	-	Ripple Ch 03	At FMC not repaired

TABLE 3.11

Diagnostic and Repair of Faulty Units transferred to FMC

Subarray	Unit/Channel	Week Removed	Index No. S/N	Index No. USP	Symptom	Parts Affected/ Repair
01C	LTA 03/04	36	5272	-	Ripple Ch 04	At FMC unrepaired
	FP RCD V	49	322	-	Immovable	At FMC unrepaired
02C	Seism. 05	49	198	0395	Nat. freq. & damping out-of-tolerance	Ready for freq. adjustment
03C	Test Gen. Card	29	5134	-	No output	Tested at FMC, o.k.
04C	LTA 03/04	33	5293	-	Lower 3 dB point & cutoff freq. out-of-tolerance	At FMC unrepaired
	LTA 05/06	33	5294	-	Lower 3 dB point & ripple out-of-tolerance	At FMC unrepaired
	AHS Card Modem	46	6968	-	B & C loop failure	Replaced Y1 & Y2
	Test Gen. Card	47	5028	-	+BB unstable	Replaced K4
05C	Test Gen. Card	35	5029	-	-BB unstable	Replaced Z7
	Test Gen. Card	37	5183	-	No 1 Hz output	Replaced Z1
	Seism. 03	46	303	0396	Noisy data	At FMC unrepaired
	Seism. Analog CH	46	121	0532	Noisy (faulty cable)	At FMC unrepaired
	FP RCD V	51	362	-	Immovable	At FMC unrepaired
06C	Test Gen. Card	29	5146	-	No +BB output	Replaced Z7
	LTA 03/04	41	5142	-	DC Offset not adjustable	At FMC unrepaired
	LTA 01/02	46	5143	-	Ripple Ch 01	At FMC unrepaired
	FP RCD EW	51	359	-	Immovable	At FMC unrepaired
08C	FP RCD EW	32	360	-	Immovable	Complete overhaul & check
	LTA V/NS	32	5244	-	Ripple	At FMC unrepaired

TABLE 3.11 (cont.)

Diagnostic and Repair of Faulty Units transferred to FMC

Subarray	Unit/Channel	Week Removed	Index No.		Symptom	Parts Affected/ Repair
			S/N	USP		
08C (cont.)	Seism. 05	32	303	-	Damping & sensitivity out-of-tolerance	Ready for adjustment at FMC
	FP RCD V	42	284	-	Immovable	Complete overhaul & check
09C	Seism. 01	28	561	-	Freq. & damping out-of-tol.	At FMC unrepaired
	Seism. 01		519	0474	Sensitivity out-of-tolerance	Ready for freq. adjustment
10C	Test Gen. Card	30	5090	-	No 1 Hz output	Replaced Z1-Z3-Z4-Z7 & K4
	Seism. 01	34	504	-	Freq. & sens. out-of-tol.	Adjusted & checked
	Test Gen. Card	37	5323	-	±BB to SP-bus failure	Replaced K3
	LTA 01/02	47	5087	-	DC offset not adjustable 01	At FMC unrepaired
11C	Seism. 01	28	559	-	Freq. & damping out-of-tol	At FMC unrepaired
	RA-5 05	28	270	0507	Low output	At FMC unrepaired
	LTA 05/06	28	5178	-	DC offset 10 V on Ch 06	At FMC unrepaired
	LTA spare	28	5177	-	DC offset not adjustable	Replaced Z2
	LTA 03/4	34	5179	-	Cutoff freq. out-of-tol.	At FMC unrepaired
	AHS card Modem	43	6769	-	B & C loop failure	Replaced Y1
	Loop unit modem	43	-	1532	B & C loop failure	Replaced C1
	Loop unit modem	44	unmarked	-	B & C loop failure	Replaced C1
	CK-card modem	44	6774	-	B & C loop failure	Replaced Y1 & Y3
	EPU	44	8	1753	Output voltages out-of-tol.	Replaced C3 &U1 on conv. reg. card
	DN-card modem	44	6763	-	No polarity switching	Replaced Y1 & Y2
	Modem	45	-	1652	B & C loop failure	Tested at FMC. o.k.

TABLE 3.11 (cont.)

Diagnostic and Repair of Faulty Units transferred to FMC

Subarray	Unit/Channel	Week Removed	Index No. S/N	Index No. USP	Symptom	Parts Affected/ Repair
12C	Test Gen. Card	29	5207	-	No +BB output	Replaced K3-K4
	LTA 01/02	43	5062	-	CMR Ch 02 not adjustable	At FMC unrepaired
13C	Test Gen. Card	37	5315	-	No ±BB output	Tested at FMC. o.k.
	LTA 01/02	37	5308	-	Cutoff freq. out-of-tol.	At FMC unrepaired
	LTA 05/06	37	5310	-	Cutoff freq. out-of-tol.	At FMC unrepaired
	LTA spare	37	5312	-	DC offset not adjustable	At FMC unrepaired
	LTA spare	37	5313	-	DC offset not adjustable	At FMC unrepaired
	AHS card modem	43	6006-1	-	B & C loop failure	Replaced Y1
	AHS card modem	47	unmarked	-	B & C loop failure	Replaced Y1
14C	LTA 03/04	44	5209	-	Ripple Ch 04	At FMC unrepaired

TABLE 3.11 (cont.)

Diagnostic and Repair of Faulty Units transferred to FMC

3.2.5 Drift of the Characteristics

The drift in mass position and free period of the LP sensors has been regularly observed. As would be expected, an abnormal drift, if any, occurred during the late fall due to larger temperature changes in the underground. For typical variations in these characteristics, see (1).

The drift of other data channel characteristics previously discussed in this report has been investigated, but no anomalies have been observed.

4. NEW FACILITIES AND FEATURES

4.1 NORSAR SP Analog Station (NAS)

From the end of November the output from a conventional NORSAR SP seismometer (HS-10-1/ARPA) and seismograph amplifier (TI RA-5) located in the LPV at 05C has been transmitted to NDPC without digitization. NORSAR Plan D telemetry equipment, Geotech AS-330 and XS-410, is used for the FM transmission. At NDPC a recording station, Helicorder RV-301 and AR-311, is installed.

Figure 4.1 shows the relative magnification of the seismograph as function of wave period. The magnification at 1.0 sec. was set to 50 000 on 22 November (implementation date). The seismic instrumentation of the station will be monitored using NDPC's AM capabilities approximately once a month. The transmission instrumentation will be controlled bimonthly. Station gain and timing are controlled daily (see (5)).

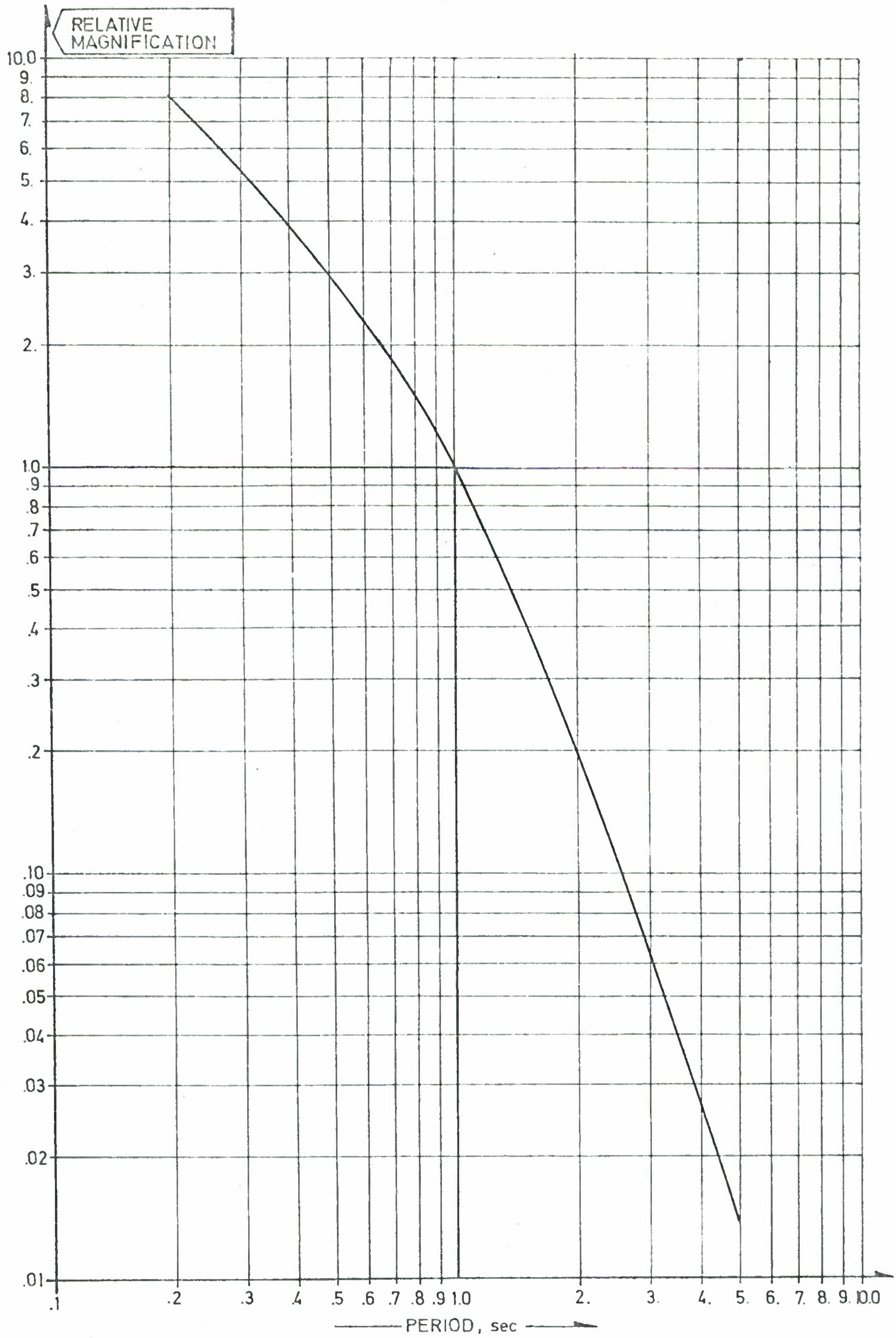

Figure 4.1 Magnification of NORSAR SP Analog Station relative to Magnification at 1.0 sec period

4.2 NORSAR Maintenance Center (NMC) at Stange

The decision to concentrate all NORSAR workshop maintenance at one site was taken during the spring 1972. FMC was not found suitable for this purpose. During the fall a site was found at Stange a few kilometers north of the CTV at 04B. The four Moelven huts previously located at MC/Kjeller were moved and prepared to serve as workshop and office facilities for the new center. Available space in one of the permanent buildings at the chosen place was rebuilt to serve as garage, storage and laboratories (see figures 4.2-4.4).

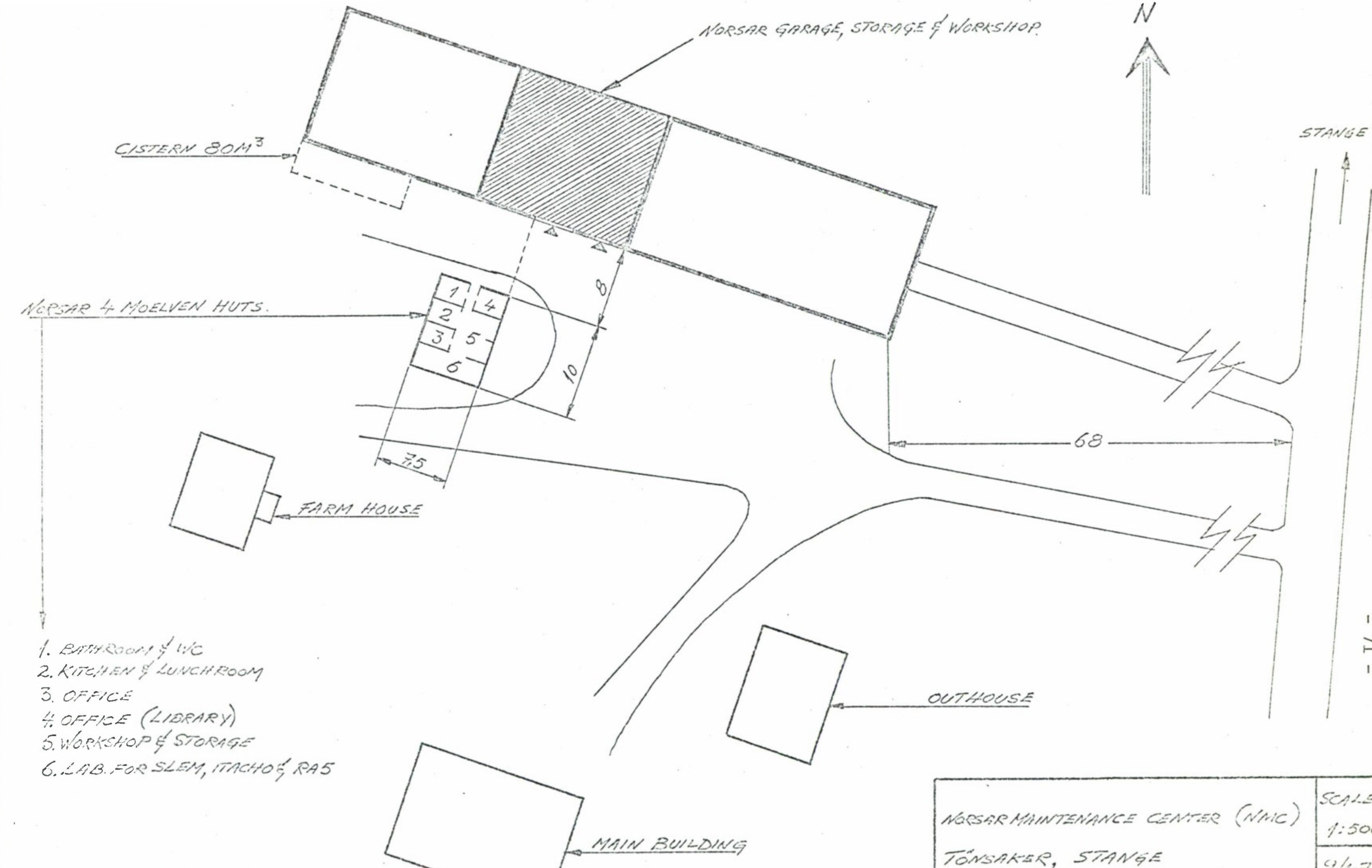

Figure 4.2 NORSAR Maintenance Center Stange

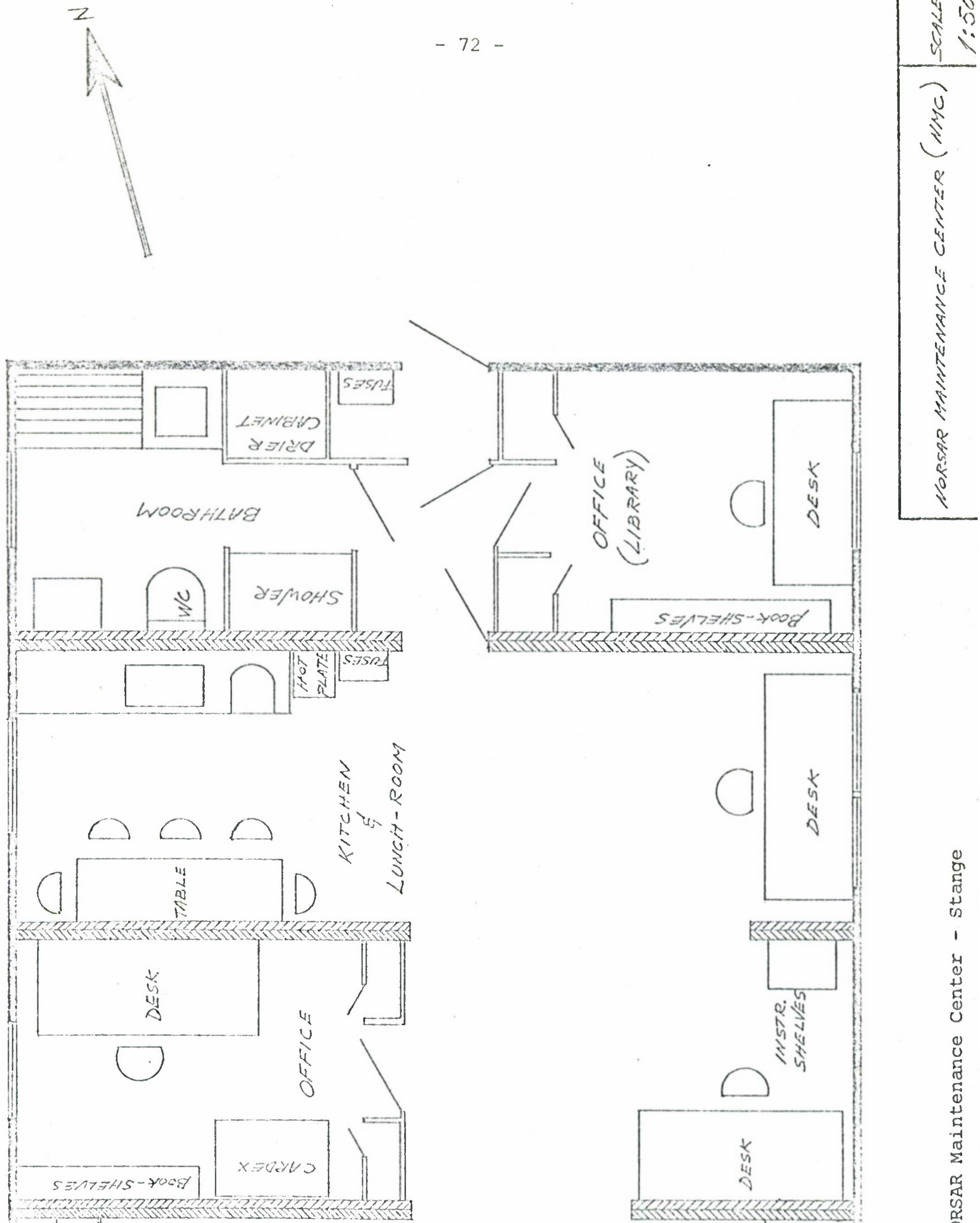

Figure 4.3 NORSAR Maintenance Center - Stange

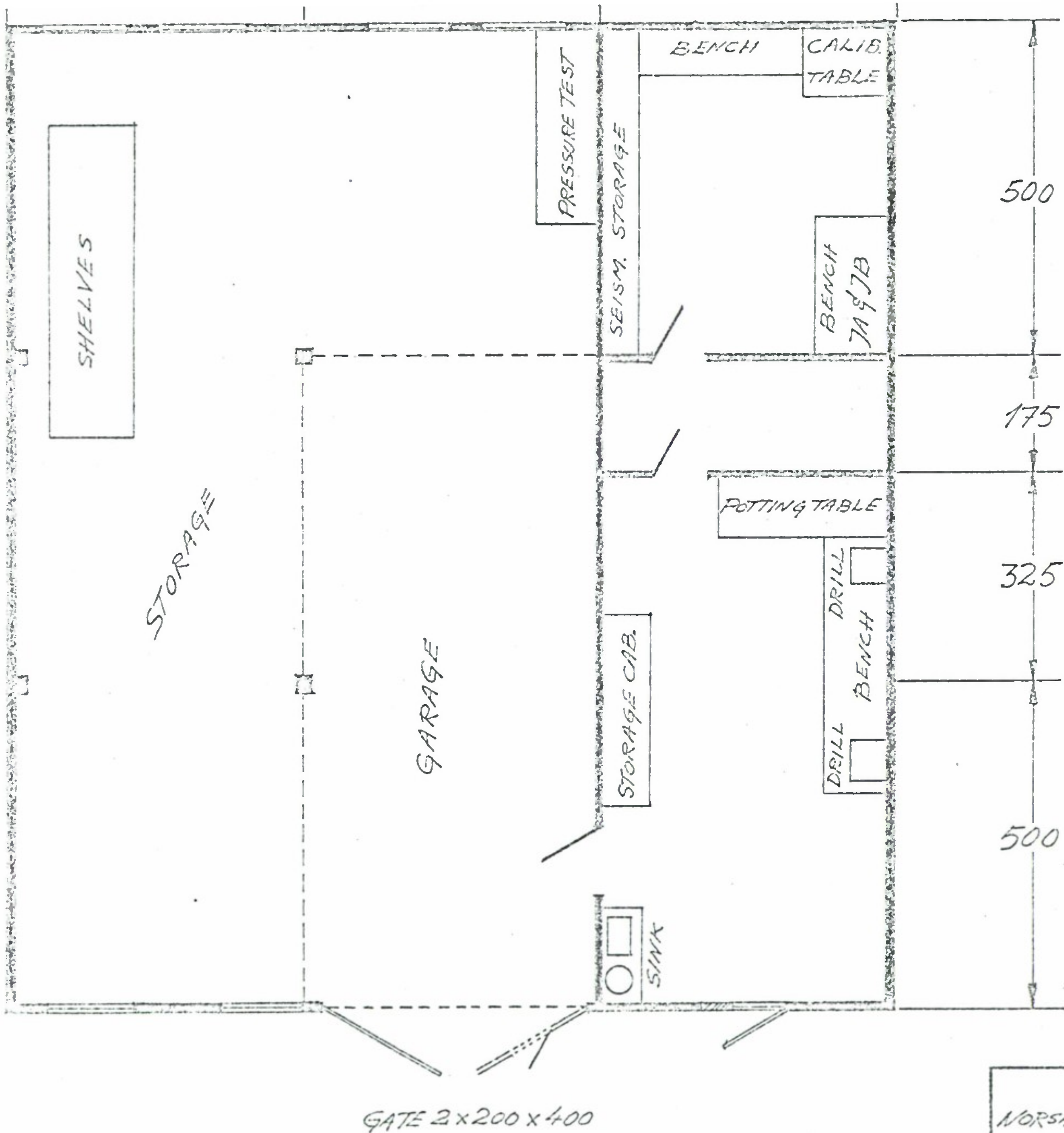

Figure 4.4 NORSAR Maintenance Center Stange

5. EVALUATION

In the period all parts of the array field instrumentation have operated satisfactorily. Compared with the results from the previous period (see (1)) the number and types of malfunctions are as expected During the previous nine-month period much work was assigned to maintenance of SP seismometers and RSA/ADCs. This part has improved considerably. The task of replacement of SP sensors with characteristics outside tolerance limits is today mostly completed. A preventive maintenance program for the instrumentation in the WHVs not yet visited will be initiated during spring 1973. After completion of this, further improvement in the stability of field equipment located outside CTVs and LPVs is expected.

The number of faulty RSA/ADCs has decreased significantly. This may be explained by the introduction of a new procedure which implies routine adjustments of even small RSA/ADC offset, channel gain, CMR and DCO. EPU voltages are also controlled. Table 3.6, however, gives only the number of adjustments/replacements which have been accomplished when the assigned characteristic has been found outside tolerance limits.

Some of the numbers in Table 3.6 should be commented. During spring last year a comparison between field and CHANEV LP measurements of LP sensor damping was performed. It showed that the computer program reported values slightly lower than those measured by the field technicians. All LP sensors have been reviewed and sensor damping ratio brought back to nominell. In no case was the discrepancy more than a few percent.

The task of adjusting RCDs which get locked during operation has continued. RCDs which have been adjusted at FMC according to the new adjustment procedure (see (7)) are all operating satisfactorily.

As in the last period the number of damaged BE-cards is large. Research to improve the construction has been initiated. Other research consists of investigations on the construction of "Water in CTV" monitor and other CTV monitors. Maintenance and repair routines for the Ithaco amplifier are in progress.

The fact that a large number of faulty LTA cards are stored unrepaired at FMC is explained by the solid state circuits of these. However, the SLEMs have a large number of spare input channels equipped with unused LTA cards. Until the spare parts situation gets critical, we will first recheck all cards reported faulty at other subarray sites and/or the present tolerances of the LTA filter characteristics reviewed before drastic dismantling of usable spare LTA cards is initiated.

An option for displaying the long-term averages of a certain subarray beam from all subarrays has been implemented at EOC and will be used for tracking of noisy data channels. An alarm for alerting the computer operator if any subarray rectifier has been in "High Charge" mode for more than two hours was implemented 18 October.

REFERENCES

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4) Suppression of SP Channel Noise, Teleplan A/S.

5) Steinert, O.: Introduction to NORSAR SP Analog Station, NORSAR Technical Report No. 44, NTNF/NORSAR, Kjeller, Norway, 1972.

6) Steinert, O.: Travel and Work Report on the Participation in the Erection of a WWSSN Station at 77^{O}N in Northeast-Greenland, NORSAR Report No. 35, NTNF/NORSAR, Kjeller, Norway, 1972.

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APPENDIX I

AM ROUTINE PROGRAMS

1 General

The tests required for AM may be summarized in four groups. Group I tests are the automatic, continually running tests that examine the normal seismic data plus the randomly addressed data that is transmitted from the array. Group II tests require operator commands from the EOC to initiate them. Exception ICW's are transmitted from SPS to a SLEM to command the test sequence and collect the test data. Group II test data will be analyzed on-line when received at NDPC. Group III tests will collect test data as do Group II tests, but the test data will be recorded on the ISRSPS High Rate tape for later analysis by programs in the EP system. Group IV tests will be initiated from the console to provide data for operator analysis on the waveform display and/or strip chart recorder. These tests will run continuously, once started, and will terminate only on command from the operator.

2 Routine AM Programs

2.1 SLEMTEST consists of Group II tests and controls the following features of SLEM:

Test	What is tested
Data Compression Test	Data compression circuits in SLEM
D.C. Offset (DCO)	Adjustment of offset circuits in SLEM which minimize dc component in data output.

Test	What is tested
Common Mode Rejection (CMR)	Adjustment of SLEM to minimize influence of common mod signals in data output.
Channel Gain	Overall gain of a short (SP) or long (LP) period channel from seismometer to SLEM output.
Test Generator	Four test signals generated within SLEM for self-test and for test of seismometers and seismometer amplifiers.
RSA/ADC Test	Adjustment of SLEM range scaling amplifier and analog to-digital converter circuit Used in conjunction with missing numbers test.

2.2 CHANEV (Group III) consists of two programs which accomplish a frequency band analysis of SP and LP channels:

Test	What is tested
CHANEV SP	The SP channels' transfer function is determined by analysis of the channel output when a pseudo random pulse sequence is applied to the channel input. From this transfer function are obtained such channel parameters as filter ripple, LTA time constant, RA-5 gain, RA-5 lower 3 dB point, seismometer sensitivity, and seismometer natural frequency. The pseudo random pulse sequence is generated by the SLEM BB generator.
CHANEV LP	Similar to the CHANEV (SP) except that the LP channel transfer function and the corresponding LP channel parameters are obtained.

2.3 SACP (Group III) consists of two programs which accomplish a single frequency analysis of SP and LP channels:

Test	What is tested
SACP SP/LP	The channel transfer function at a single frequency is obtained for SP and LP channels by analyzing the channel output when a 1.0 Hz (SP) or 0.04 Hz (LP) test signal is applied to the channel input. Characteristics of the output signal such as bias, frequency, amplitude, and distortion are obtained.
2.4 MISNO (Group III)	Test the ability of the SLEM to reproduce all possible numbers within a given range. The BB generator is used to apply brief signals to the SP channels. As the signals decay samples are taken of the different levels. After many cycles of this, the numbers should all have been reproduced. It verifies adjustment and performance of the RSA/ADC circuits.

2.5 LPCAL (Group II) consists of a combination of the following tests to accomplish a calibration of MP and FP of the LP system at a subarray:

Test	What is tested
Free Period Adjust (FPA)	The FP of Long Period Seismometers is adjusted.
Mass Position Adjust (MPA)	The MP of Long Period Seismometers is adjusted.
Free Period Calibrate	Iterative executions of FPM and FPA to a set point.
Mass Position Calibrate (MPC)	Iterative executions of FPM and FPA to a set point.
Long Period Channel Noise	Measure Long Period channel seismic noise.

APPENDIX II

Instrumentation Used in Routine Workshop and Field Maintenance

Type of Unit	Manufacturer and Type Description	No. of Units
Oscilloscope	Tektronix Type 422 with battery pack	3
- " -	Tektronix Type 555 with cart, power supply and different plug-in units	1
Storage Oscilloscope	Hewlett & Packard Type 181/A	1
Display Oscilloscope	Hewlett & Packard Model 1208A/AR	1
Function Generator	Wavetek Type 116B	1
-"-	-"- 111	1
-"-	-"- 110	1
-"-	Hewlett & Packard Variable Phase Model 203A	1
Frequency Counter	Hewlett & Packard Type 5512A	1
-"-	-"- Type 5233L	1
-"-	-"- Model 5326A	1
Digital Voltmeter	-"- Type 3440	3
Plug-in Unit, multifunction for Type 3440	-"- Type 3440,Model 3444A	3
Multimeter	Triplett Type 630NA	2
-"-	Simpson Model 269-3	2
AC Transistor voltmeter	Hewlett & Packard Model 403A	2
DC Null Voltmeter	-"- Model 419A	1
AVO-meter	Electronics AVO EA113	2
P-P Voltmeter	Hewlett & Packard 1051	1
Megger	Type BM6	2
Megger	J100/1000	1

TABLE II-1

NORSAR Field Maintenance Instrumentation

Type of Unit	Manufacturer and Type Description	No. of Units
Cable finding equipment	Type TW5	1
Decade Resistance Box	-"- PDR5/ABCDE	2
Impedance Bridge	General Radio Type 1656	1
Attenuator Set	Hewlett & Packard 305D 5W-55V	1
Wheatstone Bridge	Yen 2755-99 N9G282	1
Decade Resistance Box	Model 1432M	1
Decade Voltage Divider	Model 1455A	1
DC Precision Voltage Source	V511N	1
Precision Power Source	Type 2005	1
Power Supply	SEEM LV40	4
-"-	Lambda	1
DC Power Supply	Hewlett & Packard 6267B	1
Power Supply	-"- 6268A	1
-"-	-"- 6289A	1
-"-	Kepco MDL (ABC10-0.75)	1
Dual Channel Recorder	Brush Type 220	3
-"-	Sanborne Model 320	1
Recorder Temperature/Humidity	Hygro Dynamics Type 15-4050E	1
Probe for above	-"- Type 15-1810	1
Digital Test Unit	Philco-Ford	2
Local Test Unit	-"-	2
Data Transmission Test Set	No 1-3	2
Sweep Function Generator*	Datapulse 410	1

* Acquired December 1972

TABLE II-1 (cont.)
NORSAR Field Maintenance Instrumentation

APPENDIX III

FIELD INSTRUMENTATION TOLERANCES

System	Unit	Characteristic	Nominal Value	Dim.	Tolerance	Tolerance Li	
						Lower	U
SP	Seism	Damping ratio	0.70	-	± 0.10	0.60	[illegible]
		Natural Freq.	1.00	Hz	± 0.15	0.85	1
		Sensitivity	32	UV/UA	± 6	26	38
		Distortion	-	%	5	0	5
	RA-5	Distortion	-	%	5	0	5
		Gain (at 1.0 Hz)	74.7	dB	± 3	71.7	77
		Lower 3dB point	0.10	Hz	± 30%	0.07	[illegible]
	LTA	Distortion	-	%	5	0	5
		Gain (at 1.0 Hz)	-2.91	dB	± 6	-8.91	3
		Lower 3dB point	0.038	Hz	± 33%	0.025	[illegible]
		Upper 3dB point	4.75	Hz	± 5%	4.51	4
		Upper 0.5dB point	4.30	Hz	± 5%	4.08	4
		Time Constant	4.30	sec	± 0.3	4.0	4
		Ripple	-	%	7%	0.0	7
		CMR	-	Qu	4	0.0	4
		DCO	-	Qu	16	0.0	16
	Channel Sensitivity		42.7	pm/Qu	± 10%	38.4	47
LP	Seism	Damping Ratio	0.64	-	± 6%	0.60	[illegible]
		Free Period	20.0	sec	± 0.5	19.5	20
		Mass Position	00.0	Volts	± 2.0	-2.0	2
		Sensitivity	47.0	UV/V	± 21%	37.0	57
		Distortion	-	%	5	0.0	5
	Ithaco	Gain (at 0.04 Hz)	77.4	dB	± 1	76.4	78
		Distortion	-	%	5	0.0	5
		Lower 3dB point	5.00	mHz	± 10%	4.50	5
		Upper 3dB point	28.6	mHz	± 5%	27.2	30
		Zero dB	13.3	mHz	± 5%	12.5	14
		Roll-off	21	dB/oct	± 1	20	22
	LTA	Distortion	-	%	5	0	5
		Gain (at 0.04 Hz)	-5.5	dB	± 3	-8.5	-2
		Lower 3dB point	3.73	mHz	± 6%	3.50	3
		Time Constant	42.9	sec	± 6%	40.3	45
		CMR	-	Qu	4	0	4
		DCO	-	Qu	16	0	16
	Channel Sensitivity		2.47	nm/Qu	± 10%	2.22	2

TABLE III-1

Tolerances of SP and LP Data Channels

System	Unit Characteristic	Nominal Value	Dim.	Tolerance	Tolerance Limits	
					Lower	Upper
SLEM	SP Sine Gen: Ampl. (p-p)	6.20	Volts	± 5%	5.89	6.51
	Period	1.00	Hz	± 4%	0.96	1.04
	LP Test Gen: Ampl. (p-p)	6.20	Volts	± 5%	5.89	6.51
	Period	25.00	Sec	± 1 sec	24.00	26.00
	BB Test Gen:	3.70	Volts	± 1%	3.66	3.74

TABLE III-1 (cont.)

Tolerances of SP and LP Data Channels

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13. ABSTRACT

The report, covering the period 1 July - 31 December 1972, discusses the field maintenance of the array, the remote array monitoring and their interaction. The routines for the maintenance and monitoring tasks, and the monitoring program package are described.

All parts of the array field instrumentation have operated satisfactorily. Cable breakages, however, have caused large "down time" on certain subarrays, especially at 05B. All preventive and corrective maintenance projects initiated last period have with few exceptions been completed.

An analog seismograph, located at NDPC, has been added to the data acquisition system. A new NORSAR maintenance center has been established at Stange.

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